Tin and Tin Plate.

Their History, Production and Statistics.

By Jos. D. Weeks.

PRICE, FIFTY CENTS.

PITTSBURGH, PA.
AMERICAN MANUFACTURER AND IRON WORLD.
1892.

THE

Birmingham Iron and Steel Co.

MANUFACTURERS OF

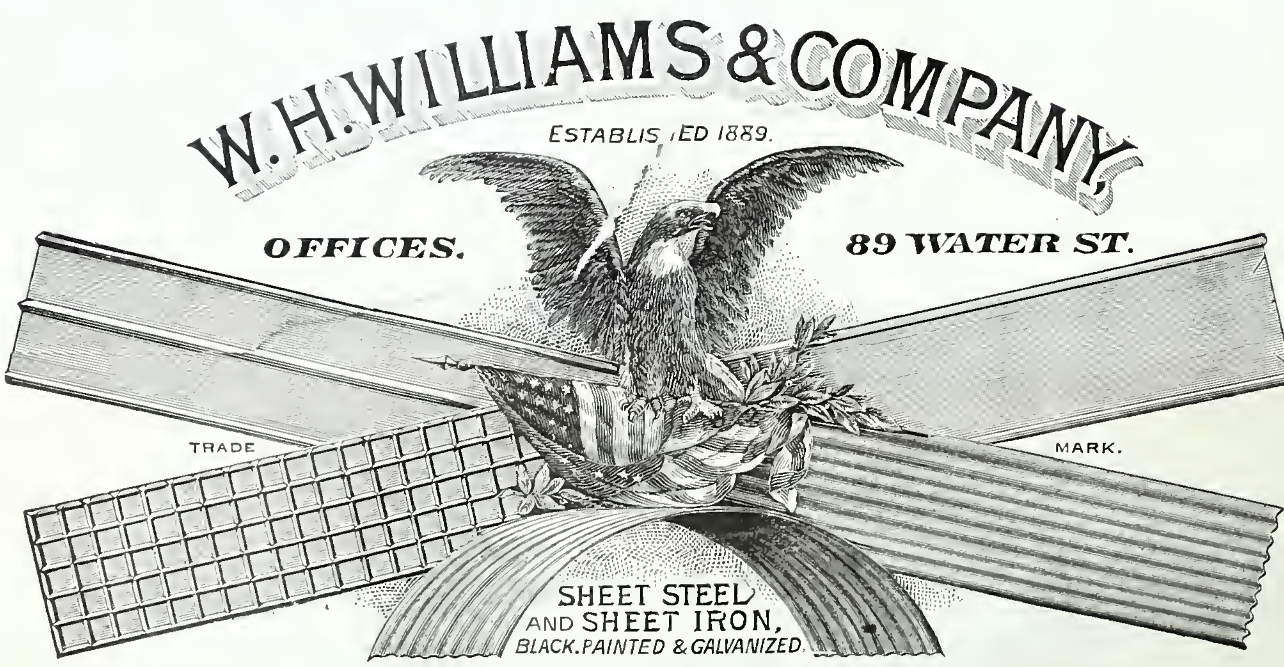
TRADE—— (B. B. B.) ——MARK.

BIRMINGHAM BEST BLOOM Sheet Steel, Sheet Iron, Black Painted and Galvanized Steel Roofing, Steel Brick, Steel Flooring, Corrugated Iron Steel Ceilings, Steel Carpeting.

THE BIRMINGHAM BOAT WORKS CO.,
Builders of Steam Launches, Tug Boats, Row Boats, Oars, &c , &c.

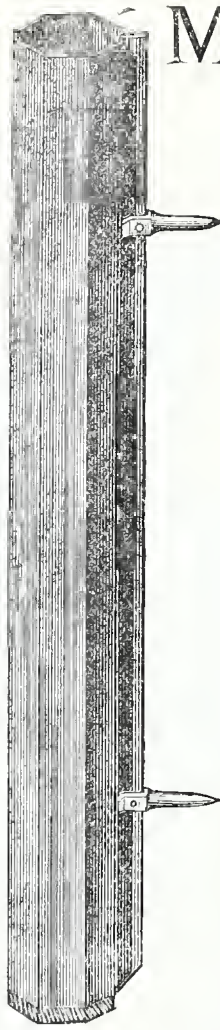
THE BIRMINGHAM ROOFING & PAINT CO.,
Manufacturers of Two and Three-ply Roofings, Roof Coatings, &c.

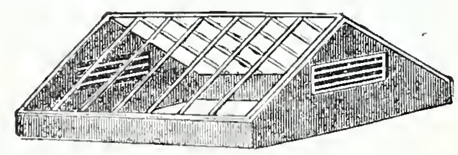
THE BIRMINGHAM MANUFACTURING CO.,
Manufacturers of the Birmingham Electric Gas Engine. The Birmingham Electric Marine Engine for small boats.

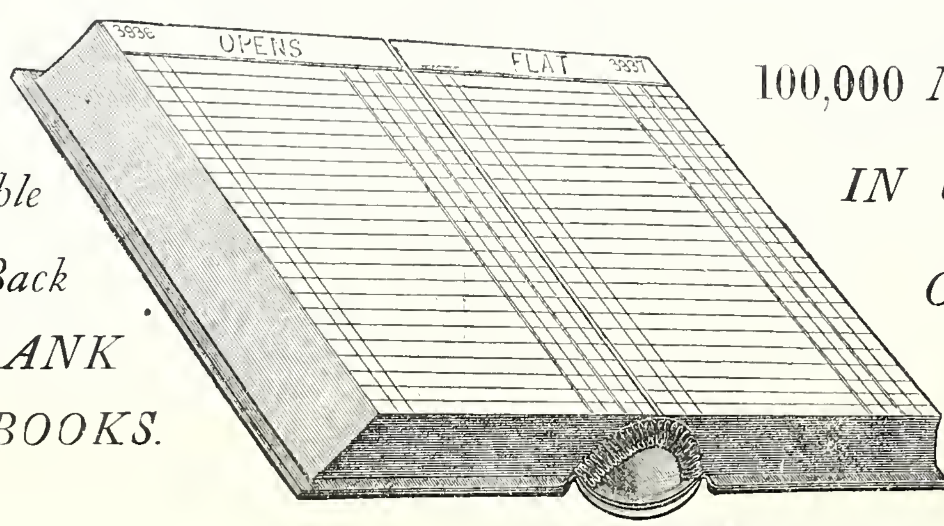


TELEPHONE 314.

PITTSBURG, PA.






OPENS
FLAT

TIN AND TIN PLATE.

Tin and Tin Plate.

CONTENTS.

Concerning Ourself.

The demand for information regarding tin and tin plate has led to the publication of this TIN PLATE SUPPLEMENT to the AMERICAN MANUFACTURER. To properly present the subject in our regular issue would have been to unduly increase its size, and it has been found more convenient to publish this information as a supplement.

The information presented divides itself naturally into 3 general heads—1st. The History, Production and Statistics of Tin. 2d. The History, Manufacture and Statistics of Tin Plate, and 3d. The Material, Processes and Machinery employed in the Manufacture of Tin Plate.

Each of these subjects has been treated exhaustively, and where it has been necessary for the better understanding of the topic discussed, illustrations have been freely used.

Under the first title, the History, Production and Statistics of Tin, has been brought together a much larger amount of information and statistics than has ever before been published in one volume. The history of tin; the character of tin ore and its occurrence, with illustrations and descriptions of noted deposits, as Cornwall, Banca, the Straits, etc.; methods of mining, smelting and refining; cost and statistics of production, with special articles on the tin deposits of the United States, are all discussed, tersely, but fully.

Under the general head of Tin Plate, first of all, the terms used in connection with this industry, about many of which there has been so much misunderstanding and misinformation, are clearly defined. The history, early and later methods of manufacture of tin plate, wages paid and earned, people employed, cost of production, and statistics and prices, as well as the history and present condition of tin plate making in the United States, are all discussed, some of these topics, where their importance demands it, most thoroughly. Exports, imports, prices and the tariff receive careful treatment.

Under the head of Tin Plate Material, Machinery and Processes, particular attention has been given to illustrated descriptions of the machinery used. Among the illustrations are 2 complete tin plate mills, one of American the other of English design, 3 pickling machines, 4 tinning apparatuses, a doubling shear, a cleaning machine and a ground plan of a complete tin mill and works. In addition to the illustrations in the text, a sheet of 4 pages of illustrations accompanies the Supplement.

On the whole we can justly claim that the subject matter has never before been treated so thoroughly and exhaustively.

In its preparation we have laid under contribution a large number of publications, chief among these to which, once for all, we desire to express our obligations are Phillips', Bloxam's, and Greenwood's, and Roberts-Austen's Metallurgies, Davis Metaliferous Mines and Mining, Flower's History of the Tin Plate Trade, the several volumes of the Mineral Resources of the United States, and of the Mineral Statistics of the United Kingdom as well as the report on Mines and Minerals of the several Australian Colonies, and the reports of the Bureau of Statistics of our Treasury Department.

The Truth About Tin and Tin Plate in the United States.

We have discussed this subject at length under various headings, stating what has been done and the causes of delay. It may not be amiss to briefly state the facts:

First as to tin. There were produced in the United States in 1892 at Temescal, Cal., 62 tons of metallic tin, more than was produced in Australia the first year of mining. Of this 20 tons were produced in December, the smelting furnace having got into operation during that month. Some 30 tons were produced in January of the present year, and the product is increasing.

In addition to this some 8500 tons of tin stuff were produced at Harney Peak, and shafts sunk and levels run, exposing upwards of 75,000 tons more of tin stuff. In Virginia between 2000 and 3000 tons of tin stuff were produced in 1891. Of these three localities Temescal is mining and concentrating; Harney Peak is mining and building the first half of a 500-ton a day stamp mill, while the Irish Creek mines, in Virginia, will probably begin extensive operations as soon as the right to purchase the mine by those who are making the present exploration accrues, which will be in April. In a word, tin mining is progressing at three works, tin concentrating and smelting at one, and a concentrating works is being built at a second. So much for tin.

As to black plates, hundreds and thousands of tons of black plate are being produced and have been sold in the United States in the last year. Quite a number of mills are prepared to furnish black plates for tinning when the demand upon them will permit. These mills are in the market to do the best they can with their product. If the best is in selling to tin plate makers, they will sell to them; if not, stampers will have the call. Our sheet mills have sold hundreds of tons of black plates the past year to be stamped and tinned. Under the provisions of the McKinley bill this black plate so tinned counts as tin plate. So much for black plate.

As for bright tin plate, it is conceded that but a comparatively small amount was made in the United States in 1891, but a great deal more than "an insignificant number of sample plates put out for campaign purposes" was made during that year, and the year 1892 will see quite a production of bright tin plate. At least 800 tons of bright tin were made in the United States in 1891. The United States Iron and Tin Plate Manufacturing Company made 229,714 pounds bright tin and 44,762 pounds terne. The St. Louis Stamping Company made a large amount of bright tin. We expect to give quite correct figures of production in the United States in 1891 in the AMERICAN MANUFACTURER in the near future.

The manufacturers of the United States, in view of all the facts, have no cause to be ashamed of their accomplishments and prospects in the manufacture of tin plate.

TIN.

Its History, Production and Statistics.

By JOS. D WEEKS.

What Is Tin?

Tin is a white metal, with a lustre appoaching silver; rarely found native, but usually as an oxide; having in its metallic state a specific gravity of 7.29, and as an oxide 6.3 to 7.1; with a characteristic lustre and a peculiar odor that manifests itself when it is slightly warmed as by being held in the hand; is very malleable and flexible, but not elastic, and emitting a peculiar crackling sound when bent. Tin exhibits a marked tendency to crystalize, as may be shown by attacking its surface with an acid that will dissolve it, as strong hydrochloric. Advantage is taken of this property to decorate the surface of tin with beautiful fern-like crystals. Grain tin is block tin crystalized.

The tin of commerce is never quite pure, but is contaminated with other metals, chiefly arsenic. Cornwall tin has a characteristically large amount of arsenic derived from the arsenical pyrites with which it is associated, while Banca, which is produced from steam tin, is the purest.

Tin, as metal used by itself, has but little commercial value. It is its uses in alloys, as in bronze bell metal, solder, etc., and for tinning iron and steel sheets and the surfaces of other metals that it has its chief value.

Definitions.

Tin stuff is the ore with the associated vein matter as it comes from the lode.

Whits is partially dressed or concentrated ore.

Black tin or *tin stone* is the fully dressed ore ready for smelting, and is nearly pure cassiterite.

Stream tin is tin ore found nearly pure in alluvial deposits.

White tin is metallic tin. It is cast in various forms and is then known as *pig tin, ingot tin, block tin*, etc.

Refined, unrefined and *common tin* are names applied to the metallic tin as it comes from the smelting and refining furnace, the names indicating that the tin is simply smelted (*unrefined*), partially refined (*common*), or fully refined (*refined*).

Grain tin is the name given to crystals of tin produced by heating the best pig tin to just below the melting point, when the mass becomes brittle and is broken up with a hammer or by letting it fall.

When the tin stuff of Cornwall shows a continuous succession of tin ore running like a stream in the lode it is called "*Benhey*," which signifies, in Cornish, a living stream. When the lode is but lightly impregnated with tin it is said to be "*just alive*." When it contains no tin it is "*dead*." The heaps of rubbish are called "*deads*."

History of Tin.

Tin alloyed with copper was beyond question one of the earliest used metals. The records left in tomb and mound and ancient dwelling clearly show that the age of bronze followed that of stone and preceded that of iron. The first recorded artificer in metals wrought in brass, or bronze as the record should read. Among the metals which Homer describes Vulcan as throwing into his furnace when he forged the four fold shield of Achilles was tin. Two of these folds were bronze, two tin. The wonderful sculptures of Egypt were cut with bronze. The small coins of Greece up to 400 B. C. were copper alloyed with tin alone, while the finds in the buried cities of the great monarchies, as well as the materials of construction and the utensils of the temples and the ornaments of the palaces of India and the great Western Asian nations show that bronze was used hundreds of years before their recorded history begins.

Where the tin for these pre-historic bronzes came from is not known. It has been doubted whether metallic tin was used in producing the alloys. Tin is so easily smelted that it does not seem probable that metallic tin was not known; but even if it were true that ore was used it only throws the question one step further back and leads us to ask, where did this tin ore come from?

EARLY SOURCES OF TIN.

Tin ore in workable quantities is not a very common mineral. To this day no deposits are known from which the dwellers about the eastern shores of the Mediterranean of those early days could have drawn their supplies except Malacca, Spain, or Cornwall. Malacca was too far away. Spanish mines were in the interior, and were not known. In all probability it was from Britain that these supplies came, and it was the Phoenicians, those wonderful navigators and merchants who made the Mediterranean a Phoenician lake and who, marking their course by the stars, brought the tin from the far off "Baratanac," as they termed the land of tin, to the artificers of Tyre and Sidon. Herodotus, writing 450 B. C., confesses that he is not "acquainted with the Cassiterides Islands from whence our tin comes. * * * However, both tin and amber come to us from the remotest parts."

EARLY ACCOUNT OF BRITISH MINES.

In an account of the tin mines of Cornwall, written about the beginning of the Christian era, it is stated of the inhabitants of that extremity of Britain, which is called Bolerion (Land's End), that "These people prepare the tin, working very skilfully the earth which produces it.

"The ground is rocky, but it has in it earthy veins, the produce of which is brought down and melted and purified.

"Then, when they have cast it into the form 'of knuckle-bones,' they carry it to a certain island adjoining to Britain and called Ictis. (St. Michael's Mount.)

"From hence, then, the traders purchase the tin of the natives and transport it into Gaul, and finally, traveling through Gaul on foot, in thirty days they bring their burdens on horseback to the mouth of the river Rhone."

BRITISH MINES WORKED BY ROMANS.

During the Roman occupation of Britain, B. C. 55 to A. D. 409, Cornish tin mines were largely worked, but in the Saxon period, 410 to 1066, they were almost entirely neglected. From the Norman conquest up to the present time, with the exception of brief periods, the mines have been regularly worked, though the product and the value of the mines to the country have varied greatly.

Up to 1240 Cornwall possessed a monopoly of the supply of tin for Europe, for though tin mines were known to exist in Spain, the Moorish wars caused them to be abandoned. In the year 1240 tin was discovered in Bohemia. In 1458 the Saxony mines were found, and in 1640 some in Barbary.

BANCA AND STRAITS TIN.

It is not known when Eastern tin was first sent to Europe, but as early as 1760 small amounts of Banca tin, where tin was discovered in 1710, were received in Holland. According to Flower the imports of Banca tin to Holland for the ten years 1760 to 1769, were as follows:

Imports of Banca Tin to Holland.

	Tons.		Tons.
1760	324	1765	279
1761	185	1766	146
1762	325	1767	167
1763	369	1768	311
1764	60	1769	457

In the year 1787 the imports of Banca tin to Holland amounted to 543 tons. This being too much for their own requirements, the Dutch began to seek a market in England. As in the same year the output of the Cornish mines largely increased, the result was a panic. The price fell from £72 to £58, and in two years the importation of Banca fell from 543 tons in 1787 to 40 tons in 1789.

Later on the first Malacca tin arrived from Singapore, and Billiton tin also became known in the markets. The mines in the Malay Peninsula were worked in 1793 by the Chinese.

AUSTRALIAN TIN.

Though attention was called to the tin deposits of New South Wales by the Rev. W. B. Clarke as early as 1853, it was not until 1872 that it was produced in a commercial way, 47 tons of metallic tin and 840 tons of tin ore having been produced in that year in New South Wales. The output increased very rapidly, and in 1874, but two years after the first mining was undertaken New South Wales produced 4,101 tons of tin and 2,118 tons of ore, Queensland 1,208 tons of tin and 4,494 tons of ore, and Tasmania 142 tons of tin and ore.

Tin Ore.

The chief, indeed the only, commercial ore of tin is an oxide (SnO^2), known as tin stone or cassiterite. When pure it is nearly colorless, but as found it is usually brown owing to the presence of iron and manganese oxides. It rarely occurs in masses but usually as small detached crystals, sometimes very minute, disseminated through the tin stuff or vein stone. These crystals are hard, heavy and brittle. The ore has a specific gravity of 6.3 to 7.1. Pure it contains 78.67 per cent of tin and 21.33 per cent of oxygen, but it usually contains small amounts of iron, manganese, arsenic, and more rarely columbite, etc. Analyses of two samples of Cornish ore are as follows:

Analysis of Tin Ore from Cornwall.

Tin	77.50	72.37
Oxygen	21.50	19.62
Ferric oxide	.75	4.32
Silica	.25	——
Water	——	2.00
Insoluble	——	1.66
	(1) 100 00	(2) 99.97

(1) Phillips' Metallurgy. (2) Cornish black tin from Moissenet.

Analyses of tin ore from the Black Hills, Dakota, show 74.5 per cent to 76.7 per cent of tin in the ore *in situ*, and 72.84 per cent to 73.21 per cent in the stream tin. This relative inferiority of stream tin is unusual, as it is generally richer than that found in the vein. Indeed, the tin used in coating tin plates in Wales was at first only that made from Cornish stream tin because of its greater purity.

Occurrence of Tin Ore.

Tin ore is invariably found in the older crystaline or metamorphic rocks, and chiefly in granite. It is not found in solid veins of tin, but in veins associated with a large percentage of accompanying gangue or matrix. The ore is disseminated through the vein stone or

tin stuff, sometimes as crystals, again in shreds, streaks and patches, and still again in minute veins passing through the vein rock in all directions. The ore separated from this vein rock and associated impurities—that is, as it is delivered to the smelter—is the black tin of commerce.

FORMS OF DEPOSITS OF TIN ORE.

Phillips notes four different forms of deposit:

First. True *veins* or *lodes* with the tin ore disseminated through the vein matter.

Second. Beds or *flats* usually connected with the true veins, but passing into the enclosing rock.

Third. Stockwerk, minute veins of the ore passing through the vein rock, usually granite, in all directions.

Fourth. Stream tin, water worn grains and nodules occurriug in alluvial sands and gravels.

Banca tin is chiefly stream tin, Cornwall and Dakota, vein tin. The new South Wales deposits were originally stockwerk, and the future mining must be in the vein, though most of the present workings are alluvial.

YIELD OF TIN STUFF.

In all cases of the occurrence of tin the proportion of tin to vein matter is quite small. The average yield of the rock from Dakota, which is regarded as especially good, is 65.85 pounds of metallic tin to the ton (2240 lb). Prof. Blake recommended the sending to the mill at the Black Hills mines all rock that carried 10 lb. of cassiterite to the ton. This would be but 7.9 lb. of metallic tin. Under this practice it is estimated that the tin vein matter of the Black Hills would yield 2 per cent of cassiterite, much of the vein yielding more than 7.9 lb.

The tin stufl of Cornwall is worked when it contains as little as ½ to 1 per cent of tin stone. It will run about 1½ per cent to 2 per cent.

TIN DEPOSITS.

The accompanying illustrations give some examples of the different tin deposits:

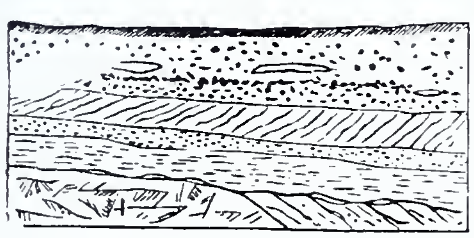


FIG. 1. Section of the Alluvial Tin Deposits, Banca.

1, granite; 2, metamorphosed slates and sandstones; 3, bed of tin ore, 3 feet; 4, coarse sand; 5, clay, red, white and black; 6, coarse sand with pockets of clay and layers of fine sand, with a little tin ore; 7, surface.

In Fig. 1 is shown a section of the alluvial tin deposits of Banca. The mode of working is described in connection with the account of Banca tin.

The stockwerk of Altenberg, in Bohemia, is shown in Fig. 2.

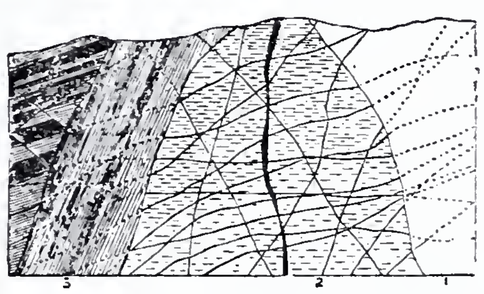


Fig. 2. Section of Tin Stockwerk, Altenberg.

1 is porphyritic granite; 2, a mass of fine porphyritic rock; 3, a mass of syenitic porphyry, and 4, porphyry very like No. 2. The whole of these beds are traversed by a network of fine veins which vary from 1 to several feet in width. These veins in 2 are more or less charged with tin. Those that have an east and west direction are richest. The tin also penetrates the adjoining rock. Indeed, the whole of 2 is impregnated with tin, especially where quartz prevails. This is also true of 4, and to a less extent of 3.

Fig. 3 is a section of the tin lode at Wheal Uny mine, Cornwall.

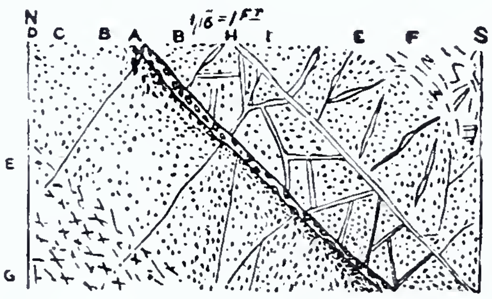


Fig. 3. Section at Wheal Uny, Cornwall, above the 110 fathom line.

G is granite; F, killas. The lode is between these two, the tin being chiefly in B, which is a compact schorl; H, a clay vein, and C, a schorl like B.

Fig. 4 is a plan of the lode at East Wheal Lovell mine, at Redruth.

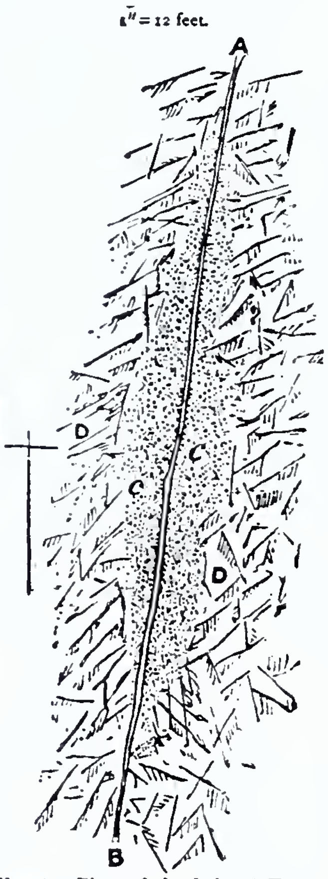


FIG 4 Plan of the lode at East Wheal Lovell mine, Redruth.

A B is the tin lode; C C, gravel impregnated with tin ore, and D D, granite. This pipe of ore varies in length from 12 to 16 feet, and in breadth from 9 to 12 feet. The granite, D, contains large crystals of orthoclase. The tin stuff, C C, is made up of a mixture of quartz, mica, gilbertite, fluor spar, iron and copper pyrites and tin stone. Sometimes the tin ore inclines more to one side than the other. This ore has been followed down the 40-fathom level to the 110-fathom as one continuous pipe. In places, when tin was selling at £80 a ton, this lode was worth £800 to £1000 a fathom, and generally gave 5 to 6 tons of tin per cubic foot.

Fig. 5 shows a Cornish equivalent of stockwerk, it being the granite mass at Cligga Point:

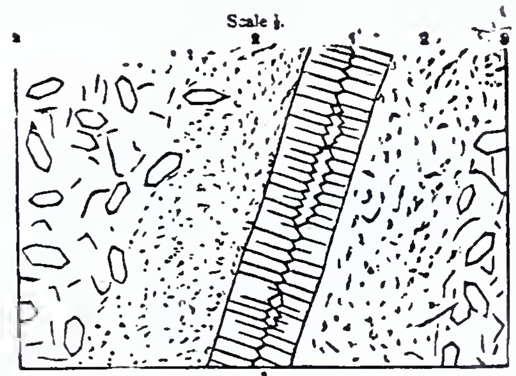


FIG. 5. Granite with tin veins, Cligga Point, Cornwall.

This mass is 300 feet high and is traversed by a great number of nearly parallel veins. 1 is quartz; 2, greisen; 3, granite. The width of the veins varies from ½ an inch to 6 inches wide, and they lie from a few inches to a few feet apart.

Cost of Producing Tin.

From Davies' *Metalliferous Minerals and Mining* we take the following particulars of prices paid for general mining work in Cornwall:

The sizes of shafts in the county are from 5 to 15 feet long, by 3 to 5 feet wide. The prices paid for sinking shafts are:

	Per fathom.
In soft clay slate, to a depth of 20 fathoms from surface	£ 2 to £ 3
For same below this depth	3 to 4
In hard clay slate, to a depth of 20 fathoms	4 to 6
For same below this depth	5 to 8
Where powder is used, or in ordinary blasting ground, to a depth of 20 fathoms	6 to 8
For same below this depth	10 to 30
In extreme cases of hardness	70 to 80

Driving levels, about two-thirds of the preceding prices. Smaller levels in easy ground are driven at from 8s. to 12s. per fathom forward.

Stoping costs about two-fifths of the price of driving levels.

Average cost of breaking and selecting the ore and sending it to the surface, 4s. to 8s. per ton.

The eight mines named below gave, in 1866, the following proportions of black tin to the ton of ore raised.

	Lb.		Lb.
Huel Kitty	84	East Carn Brea	18
Dolcoath	56	Polberro Consols	14
Tincroft	35	Huel Coates	6
Huel Uny	23	Llanwit	4

At St. Ives Consols as much as 1344 pounds have been obtained to the ton of ore, but the average is only 45 pounds.

In 1856, of thirty-two of the best mines the highest average was given by Huelvor, which gave 144 pounds to the ton of ore.

The present percentage of black tin derived from all the tin ore sent through the stamps and dressing floors of Cornwall is estimated at 2 per cent, or nearly 45 pounds to the ton of ore.

In 1877, 14,142 tons of black tin gave 9500 tons of metallic tin. It may be taken, therefore, that 100 pounds of black tin yields about 70 pounds of metallic or block tin.

The cost of mining and preparing tin ore for the market has decreased during recent years at the best mines from £52 to to £27 per ton. Possibly £35 may more nearly represent what at present may be considered the lowest average price as spread over a number of the best mines.

Fifty tons of ore will ordinarily have to be mined to produce one ton of black tin. If we put the cost of stoping per fathom at £3, and take four square fathoms of a lode four feet wide as equal to 50 tons, this would give £12. The cost of dressing, from the pit's mouth to the ore bin, varies from £5 to £12, but £9 is taken as the average; this would make £21. Then come dues, cost of management, pumping and renewals, so that we cannot at present reckon upon a much less cost than £35 per ton.

At the stockwerk of Altenberg, Saxony, Fig. 2, the whole mass is quarried, stamped and washed; the proportion of black tin being 2 per cent of the whole.

At the alluvial tin mines of Banca, Fig. 1, a workman in a day of nine hours removes, with the aid of water, from 350 to 530 cubic feet of earth. The top ground is dug off and removed, and then a stream of water turned on. Bowls, launders and strips or strakes, are used for intercepting the tin, as in alluvial gold mining. The experienced laborers receive £1 per month and their board. The newcomers only receive 13s. 4d. and their board. The quantity of earth removed yearly for each person of all sorts at a mine is estimated at about 12,000 cubic feet; the yearly yield of metallic tin for each employe of all kinds being 12 cwt.

In Australia, in washing for steam tin a man is said to handle or pass through his hands, 10 tons of earth a day.

Tin-Producing Localities.

The world's supply of tin comes chiefly from Cornwall, the Malay Peninsula (Straits), the islands of Banca and Billiton, Dutch Possessions in the China and Java seas, and the Australian Colonies, New South Wales, Queensland and Tasmania. Small amounts are still produced from the old workings in Saxony, and still smaller amounts from Italy, Austria-Hungary, Russia, Peru, Bolivia and Japan. In 1891, for the first time in recent years, Mexico and the United States produced tin at Durango in the former country and Temescal in the United States. As yet no metallic tin has been produced in a commercial way from the Dakota or Virginia mines, though at both, especially at the Harney Peak Company's mines, a large quantity of tin stuff has been mined, and it is reported that some concentrating has been done in Virginia, though no ore has been smelted. It is said that a large amount of work will be done in both of these localities in 1892.

From the above statement it will be seen that the producing localities are few. It is a notable feature of tin mines, however, that when one is a producer, it can be relied upon for many years. Cornwall has been producing tin for at least 2500 years, Banca since 1710, and the Malay Peninsula for a long time; and there seems a supply at the present rate of production for centuries to come. The mines of the Australian colonies have been producing since 1872, but in the stream tin and the lodes there are enormous deposits of tin yet unworked, possibly unknown or unsuspected.

Cornwall Tin.

The oldest as well as the best known tin deposit is the Cornwall, the district including deposits not only in Cornwall but in Devon as well. Both stream and vein tin are worked, though by far the larger part of the tin is derived from the veins, most of the stream tin now produced being from the sands or tailings of the dressing plants.

The tin veins, which are more recent than the enclosing rocks, are found either in granite or what is known as *Killas*, which is a metamorphic clay-slate. The veins are most productive in the vicinity of the line of junction of these rocks. The lodes of ore at times split up into fine thread-like veins so penetrating the slate that they must be worked together.

The gangue or vein rock, the tin stuff in which the tin is found, is in most cases quartzose matter. The minerals associated with the casseterite are remarkably constant, being wolfram, mispickel, apatite, topaz, tourmaline, mica, etc. Cornwall tin also has associated with it arsenical pyrites from which is derived the arsenic which is the chief impurity of the metallic tin.

MINING LEASES IN CORNWALL.

It is questionable if anywhere else on the face of the earth the rights of the land owners are carried to the extent they are in Cornwall. Not only is every inch of land appropriated, but the streams, and in many instances the harbors, are held as private property. It is impossible to purchase a freehold for dwellings, and the running leases which are granted are on very severe conditions. These leases are for short terms, say 20 years or less. The adventurer, as the lessee is called, pays a rent and a royalty varying from one-tenth to one-twenty-fifth of the produce. He not only has to sink a shaft, but to erect extensive pumping and other machinery which becomes the property of the land owner at the expiration of the brief lease. When the lease is drawing to a close the negotiations for its renewal are long and anxious. The land owner, if the venture has been a successful one, strives to increase the rent, while the tenant naturally desires to reap the advantage that has come from his work and risk. The tenant has the recourse of spoiling the mine by obliterating all signs of the deposit and flooding it. Cornwall is full of springs, and flooding is secured by neglect. The system is rapacious and mischievous in the highest degree.

PRICE OF CORNISH TIN ORE.

On the first of 1892 the price of tin ore in Cornwall was £59 per ton. As pig tin was worth £90 15s. to £91 2s. 6d., it will be seen what is the margin for smelting and refining. The Cornish tin ores average about 65 per cent to 70 per cent metallic tin.

MINING AND DRESSING ORE IN CORNWALL.

According to published statements, the ore dressing, if not the mining methods employed in Cornwall, while not as crude, perhaps, as those of the Malay Peninsula, are in many cases wasteful, unscientific and expensive in labor. A recent writer, speaking of crushing the ore before dressing, says: "Blake's stone breakers, although excellent and well proved machines, are not nearly in such common use in this country as they should be; too much reliance is still placed in the muscular arms of the maidens."

The mining methods employed are the well known Cornish. The development of mining machinery in this district has given us some of the best known forms of pumping machinery, but it is to be feared that the miners are so well pleased with what they have done as to believe practically, if not theoretically, that improvements cannot be made upon them.

AMERICAN STAMPING AND CONCENTRATING MACHINERY.

On the other hand, great improvements have been made in the United States in dressing machinery, or to use the word commonly adopted in this country, concentrating machinery. The great demand in connection with quartz gold mining, and especially in working the low grade copper ore of Lake Superior, for effective, rapid and labor-saving machinery, has led to the invention of new machines and the perfecting of old ones, so that in our American tin mines old Cornish machines and methods will be superceded. At the Temescal mine Cornish machinery, on which a duty of $3500 had been paid, laid for months, if it does not now, at the railway station, while an American concentrating plant is being worked to the perfect satisfaction of the old Cornishman who has charge of the works.

ASSORTING AND BREAKING THE ORE.

As the tin stuff is raised from the mines it is roughly cleaned from the earthy matters by washing it upon a grating under a stream of water. It is then picked over and broken with a mallet, the copper pyrites associated with it being placed aside to be smelted for that metal, and the iron and arsenical pyrites rejected as far as possible. This is the work that is done by "the muscular arms of the maidens" instead of by the Blake crusher as recommended by Mr. Frechville.

STAMPING.

After being thus roughly crushed and separated from the copper, iron and arsenical pyrites, the tin ore is crushed in a *stamp-chest*

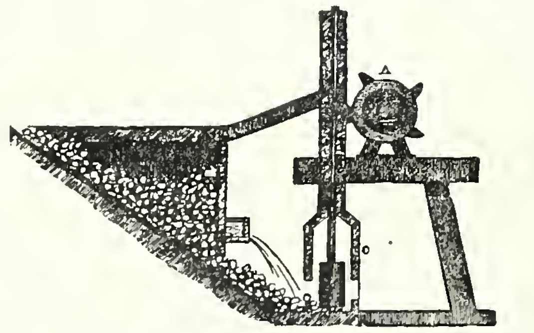


FIG. 6. Section of Stamping Mill.

(Fig. 6), a wooden trough lined at the bottom with stamped ore and provided with a number of wooden stamps shod with blocks of cast iron weighing about 2½ cwt. These stamps are raised by arms fixed to an axle, each stamp giving about 20 blows in a minute, the stamps moving through spaces of about 8 or 10 inches. The ores are reduced to powder under this action, and a stream of water which constantly flows into the trough carries this powder through openings in three sides of it which are closed with iron plates perforated with about 160 holes per square inch so that the larger fragments may not pass through. The holes in the iron plate are conical, having narrower openings inside the trough to prevent their becoming choked. The water carries the powdered ore into a series of reservoirs into which the ore settles by reason of its greater specific gravity, while the water flows away. The tin stone or ore being much heavier than other substances present, the greater part of it is deposited in the first reservoir, the successive deposits becoming poorer in tin as the stream flows on. The sand, which has a specific gravity of 2.7, as compared with 6.5 to 7.0 of the tin stone, is in a great measure carried away.

WASHING THE SLIMES.

Various mechanical contrivances are adopted for effective water purifications of the *slimes*, in which advantage is taken of the high specific gravity of the tin stone. The

FIG. 7. Rack for Washing Ores.

rack, which is quite commonly used, is an inclined plane of wood, with a shallow ledge (g), about 9 feet long, having one end 5 or 6 inches higher than the other. It is swung upon a pivot (D) on each end so that it can be tipped and the contents emptied from the side. About 25 pounds of *slimes* are spread upon inclined shelf (II) at one end of the inclined plane or *rack* whence they are washed by a stream of water onto the inclined plane (F) or *rack*, where the sand or other earthy portions are carried away by water, while the tin stone, with some pyrites, is left upon the plane. The deposit formed upon the higher portions of the incline is fit for calcining or roasting, that formed on the lower part requires another washing.

The *buddle* is a fixed inclined plane worked in a similar manner. The *tossing tub*, *dolly* or *kieve* is a tub in which the powdered ore is stirred up with water and allowed to settle, the settling being hastened by striking the tub.

PRODUCT OF TIN STONE IN DRESSING.

In a paper on the Cornish system of dressing ore Mr. R. J. Frechville gives some very interesting data as to the percentage of tin stone to the tin stuff, wastes, cost of dressing, etc. Mr. Frechville states that the main principle in dressing these ores consists in crushing the tin-bearing rock by stamping and obtaining therefrom 2 to 3 per cent of cassiterite by washing off the light rock with large streams of water—"buddling." The loss by this process is so considerable that plants for working the settlings from the streams so used are established at intervals between the mines and the mouth of the rivers.

Of 302,035 tons of tin stuff treated on the Red river in Cornwall, 7332 tons of black tin were obtained at the mines, 283,549 tons of sand and slimes were discharged into the Red river, and 10,000 tons of sand were placed in the burrows of Tincroft.

The actual contents in black tin of this 302,035 tons of tin stuff treated, as well as its

market value, and the average price per ton obtained, are given in the following table:

Contents of Tin Stuff from Red River Mine, Cornwall.

	Statute tons.	Price.	Average price per ton.
			£ s. d.
Black tin obtained at the mines,	7,302	£334,865	45 13 5
Black tin obtained from the stream works,......................	1,154	35,016	30 6 10
Black tin locked up in 10,000 tons of sand on Tincroft burrows (estimated value at £40 per ton)................................	14	560	....
Black tin finally lost in St. Ives bay (estimated value at average price of stream tin ore)...	190	5,765	....
Totals..............................	8,690	376,206	....

From the above it appears that the tin stuff originally contained 64.44 pounds of black tin per statue ton. Of this amount 54.37 pounds, or 84.37 per cent, was saved at the mines; 8.55 pounds, or 13.27 per cent, by the stream works; 0.11 pound, or 0.17 per cent, remains locked up in Tincroft burrows, and 1.41 pounds, or 2.19 per cent., was lost in the sea. It must, however, be taken into consideration that the black tin obtained from the stream works is not of the same value as that obtained at the mines. During 1884 the average produce in metal of the latter was 66 per cent, and of the former 53 per cent only; so that it is more correct to make the above calculations on the basis of the market value of the ore. Thus, of the £376,206 worth of black tin contained in the tin stuff dressed, £334,865, or 89 per cent, is to be credited to the mines; £35,016, or 9.3 per cent., to the stream works, and the remainder, £6,325, or 1.7 per cent, constitutes the loss. All who have a practical knowledge of ore dressing must admit that the saving by the mines of 89 per cent of the value of the stuff treated is a very good result indeed—in fact, much better than had been anticipated when this inquiry was commenced. Nevertheless, it is believed that it is possible in some slight degree to increase the efficiency of the process.

COST OF ORE DRESSING.

As to the cost of ore dressing, Mr. Frechville says: "Having gone very carefully into this matter at two of the leading mines, it is found that, including every charge from the time that the tin stuff is delivered to the stamps until the ore is ready to be sent to the smelters, the cost amounts to 5s. per ton of tin stuff dressed. This includes a charge for repairing the floors, but not for depreciation in value of machinery. Adding 2d. per ton for this item, would make the total cost 5s. 2d. per ton. This is the weak part of the process. The cost, owing to the large amount of manual labor employed, is too high, and in these days of improved machinery of all descriptions, should most certainly be reduced. During 1884 the mines that contributed to the Red river employed 4725 persons; of these, 2571 worked at the surface and 2154 underground. Of the surface hands, 75 per cent, or 1928 persons were engaged in the dressing floors. Labor is cheap and plentiful in Cornwall, so that there is not the same necessity that exists in some other countries, the United States, for instance, of introducing automatically working machinery; but the employment of such an excessive amount of manual labor is an abuse of the advantages, and not in keeping with the scientific progress of the age."

ROASTING TIN ORE.

Much of the Cornwall tin ore has associated with it arsenic, sulphur and iron in the form of pyrites. The arsenic and sulphur are driven off by roasting. The arsenical oxide which results from the roasting is carried into condensing chambers where it is deposited in crystallized form. If the ore contains much copper it is usual to treat it with dilute sulphuric acid before removing it from the burning floor. The roasting is done in large furnaces holding from 6 to 8 cwt. The charge is rabbled every 20 to 30 minutes, the temperature being kept low to prevent the formation of sulphide of tin. The roasting requires 12 to 18 hours, when the charge is drawn, exposed to the atmosphere for a few days and then transferred to a large tank containing water. The heavier portions, containing the most metal, are collected at the bottom and form the black tin.

Recently rotary calciners have taken the place of the reverberatory furnace for roasting. This does away with manual labor in burning the ore. The work is done more quickly, more thoroughly and more economically.

TIN SMELTING AND REFINING IN CORNWALL.

The ore thus concentrated and calcined is called black tin and is ready for the smelter. Formerly small blast furnaces were employed (see description of Temescal tin), but reverberatories are now used. These vary in form, but are usually a truncated oval in shape, some 12 to 18 feet long by 8 to 9 feet wide in the widest part.

THE TIN SMELTING FURNACE.

The furnace in use in Cornwall is shown in plan and vertical sections in the accompanying illustrations (Figs. 8 and 9). The hearth of the furnace C is about 18 feet long by 9 feet wide in the widest part.

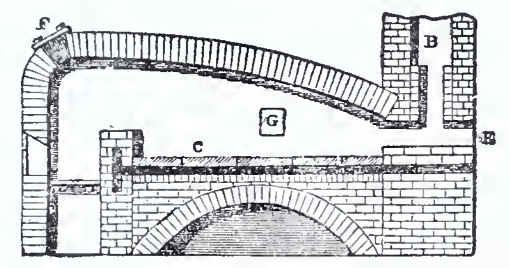


FIG. 8. Tin Smelting Reverberatory Furnace. Vertical Section.

The furnace is shallow from hearth to roof, the hearth inclining from all parts towards the top hole, D, on the opposite side, to which are the doors G through which the furnace is charged and the charges rabbled. The fire box, A, is about two feet long, with the stack, B, at the opposite end of the furnace. The

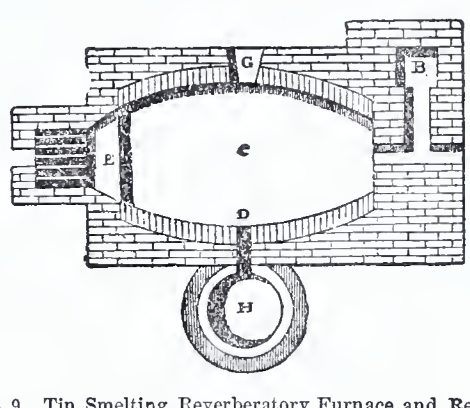


FIG. 9. Tin Smelting Reverberatory Furnace and Refining Kettle. Plan.

fire bridge, E, about 14 inches in depth, is hollow and without the usual cast iron bridge plate, the fire being kept above the bridge during the smelting. Below the tap hole is the float H, a quadrangular or circular basin or ladle of sheet iron lined with clay, into which the tin is tapped from the furnace. On the right side of the *float* is placed a *kettle* of cast iron set over its own fire in which the refining operation is performed. The bottom of the furnace is formed of iron bars, laid transversely, on which rests a bed of slats, above which is a bed of from 7 inches to 8 inches in thickness of fire clay. A bottom thus made lasts some three months. Above the refining kettle or basin is a pulley from which is hung the apparatus for plunging the billets of wood to the bottom of the pot and at the same time giving them a rotary motion.

REFINING AND SMELTING PROCESS.

In this furnace two distinct operations are conducted:

1st. Smelting, in which the tin ore is deprived of its oxygen and impure tin obtained, the impurities being chiefly iron and arsenic.

2d. Refining this impure tin.

A charge of some 25 cwt. of black tin containing some 65 per cent of metallic tin is mixed with about one-fifth of its weight of anthracite slack coal, the whole mixture being wet to make it more easily handled and to prevent its being blown away, and is charged into the furnace. Sometimes a little slaked lime or fluor spar is added. The side doors are lifted up and the tap hole stopped with clay. The temperature of the furnace is gradually increased, and at the end of five hours the mass is well rabbled and anthracite slack thrown into the furnace. The mass is again rabbled after a lapse of 45 minutes, and in 15 minutes more the metal is ready for tapping.

Three products result—tin, glass and slag. The *slag* is a scoriaceous mass, containing shots of metal, which remains in the furnace after tapping and is raked out, cooled, stamped and the short tin washed out, while the slag proper is resmelted. The *glass* is a real fused slag or cinder, and runs out with the tin in tapping. The tin is first tapped into a float or ladle, and after the glass which rests upon the top is skimmed off, is cast into slabs.

For working off this charge of ore about 15 cwt. of coal and 5 cwt. of slack are used.

LIQUATION.

The tin slabs are refined in a furnace similar to that in which they were produced.

Before the refining proper the tin first undergoes a process of *liquation.* About 18 tons of the slabs are placed on the furnace bottom, the temperature being gradually and carefully raised so as to melt the tin without wholly melting the slabs. The tin, which is more fusible, is "liquated," and flows off into the refining kettle, while the less fusible portions of the slabs known as *hard head,* containing among other constituents some 50 per cent of iron and 20 of tin, remain in the furnace bottom.

REFINING.

When the kettle, which is about 4 feet 6 inches in diameter and holds some seven tons, is filled, billets of green wood, apple by preference, are thrust into the metal which is kept molten by a fire under the kettle. This operation is called "poleing." The gases disengaged from the wood cause the tin to boil, and a scum containing the impurities rises to the surface and is skimmed off. This scum is almost identical with the *hard head.*

This refining process is continued from one to eight hours according to the amount of impurities present, and also to whether common or refined tin is made. Common tin is produced in an hour. For refined tin much longer time is required.

The same effect as is produced by poleing can be secured by what is called "tossing," which is accomplished by the workmen constantly lifting the molten metal in a ladle and letting it fall from a considerable height into the refining pot.

The slags are resmelted and liquated by the use of fluxes and higher heats than those used in smelting.

The total consumption of fuel per ton of metallic tin produced is 30 to 35 cwt.

Production of Tin in Great Britain.

The first statistics of the production of tin in Great Britain we have been able to find are of the beginning of the 18th century, when Queen Anne is recorded as having a stock of 5000 tons, equal to five years consumption. Since 1750 the statistics have been kept with considerable care, though there are no accurate records for some of the earlier years. In 1750 the production of Cornwall was 2886 tons. Up to 1786 the production in no year, with two exceptions, reached 3000 tons nor fell below 2273 tons. From 1789 to 1797 the production was about 3000 tons per year, the highest being 3809 tons. From 1798

to 1816 it was but once over 3000 tons, and in one of these years it was as low as 2036. From this date it gradually increased, sometimes falling back to 3000 tons and then advancing to 8000 and 9000 tons until in 1863 it reached 10,006 tons. The largest production was in 1871, when 10,900 tons were produced. In 1890 the production was 9602. There has been but little difference in the tin production of Cornwall in the last three decades, being 94,029 in the decade beginning with 1861, 96,544 in the decade 1871 to 1880, and 92,339 for the ten years ending 1890.

In the following table are given the production and prices in London of British tin since 1855:

Production of Metallic Tin in Great Britain, 1855 to 1890, and Prices of same in London Market.

Year.	Production, Tons, 2240 lb.	Price.	Year.	Production, Tons. 2240 lb.	Price.
1855.....	6000	£117 to £130	1873.....	9972	£133 7d. 0s.
1856.....	6177	129 to 142	1874.....	9342	108 8 0
1857.....	6582	108 to 146	1875.....	9614	90 2 0
1858.....	6920	119 2s. 2d.	1876.....	8500	79 10 2
1859.....	7100	131 18 3	1877.....	9500	73 3 6
1860.....	6695	136 3 1	1878.....	10,106	65 12 3
1861.....	7450	122 5 0	1879.....	9532	72 6 0
1862.....	8476	116 0 0	1880.....	8918	91 5 0
1863.....	10,006	117 0 0	1881.....	8615	97 9 3
1864.....	10,108	107 1 0	1882.....	9158	97 to £117
1865.....	10,039	96 5 0	1883.....	9307	88 to 101
1866.....	9990	88 12 6	1884.....	9574	77 10 to 90
1867.....	8700	91 17 3	1885.....	9331	74 15 to 97
1868.....	9300	98 0 0	1886.....	9312	97 to 106
1869.....	9 60	123 2 0	1887.....	9282	104 to 148
1870.....	10,200	127 8 6	1888.....	9241	82 to 165
1871.....	10,900	137 10 0	1889.....	8912	92 to 102
1872.....	9560	152 15 0	1890.....	9602	94 10 to 105

Straits, Banca and Billiton Tin.

In the term "Straits" tin is included, all tin that comes from the Malay Peninsula. This is sometimes called Malacca tin. It does not include Banca and Billiton tin, but as the deposits on these islands are of the same character as those of the "Straits," they are discussed together. Banca is an island off the southeast coast of Sumatra; Billiton, or Biting, an island just southeast of the Malay Peninsula. The Straits Settlement proper is the southeast extremity of this Peninsula.

TIN DEPOSITS OF THE EAST INDIES.

Though all of the tin at present produced in this East Indian district is from stream tin, some of which is of remarkably purity, "flood" tin, as it is called locally, the mother lode is the quartz veins of the long granitic axis of the peninsula and its continuation in the islands of Billiton and Banca. From these quartz veins large quantities of cassiterite have been worked down into the lowlands at the base of the mountains where it is found in seams or pockets 10 to 20 feet or more below the surface line. No attempt has been made to work the lodes, which resemble those of Cornwall, but are much richer, and which contain an immense store of tin for the world's future demands. The tin stone, when separated from the clay in which it is found, looks like coarse black sand, but is remarkably free from arsenic, sulphur, wolfram, etc. At times the crystals are so pure as to be translucent.

METHOD OF MINING ON MALAY PENINSULA.

Mining is done almost entirely by the Chinese, the methods being crude and primitive. Europeans—English and Germans—have attempted mining by improved methods, but the Chinese hold their own.

Nearly all the alluvial lands and swamps near rivers and not far from high hills or mountains in the peninsula are tin-bearing. In getting out the tin the jungle is cleared and burned; the swamp drained when drainage is possible, or if not, pumping is resorted to; the soil covering the placer deposit is stripped off and the mining of the ore and concentration begin. The tools, the pumps, the washing and smelting apparatus are primitive, but effective and ingenious.

The mining tools consist of a common hoe and a small flat cane basket holding about four pounds of earth. One of these baskets is placed at either end of a stout bamboo pole balanced over the laborer's shoulders, carried off and emptied, while the man with the hoe scrapes together more soil and fills more baskets.

The tin is separated from the soil in a primitive trough washer in the same manner as gold was "washed" in the placer diggings of California at an early day.

The Chinese smelt the ore in a crude way at the mines, and send the slabs to Penang or Singapore where there are large smelters, to be purified and cast into marketable slabs. The English and German companies do not smelt at the mines, but send the black tin to Singapore to be smelted.

PRICES OF TIN AT SINGAPORE.

As a matter of interest it may be stated that the price of tin at Singapore in 1884–85 fluctuated between \$30 and \$33 a picul (133⅓ lb.), or from about 22½c to 25c a lb. In 1886 it advanced to \$36 a picul. At the beginning of 1889 it was \$37.75 a picul, at the close \$31. In May 1891, \$32.80.

PRODUCTION AND PRICES OF STRAITS TIN.

The statistics of the production of Straits tin are not as complete as could be wished. The figures of production are usually those of exports from Penang and Singapore to the United States and Europe. In addition to these exports some tin is sent to China and Japan. When the exports to these Eastern countries could be obtained they have been added to the American and European exports. The prices in the accompanying table are London prices:

Production of Straits Tin, 1860 to 1891, and Prices of the same in the London Market.

Year.	Production, Tons, 2240 lb.	Price.	Y'r.	Production, Tons, 2240 lb.	Price.
1860.....	4529	£131 3s.	1876....	9521	75 10
1861.....	4343	119 3	1877....	3014	70 10
1862.....	3931	116 0	1878....	8000	61 7½
1863.....	3060	120 6	1879....	10,985	71 19
1864.....	4564	106 1	1880....	14,763	86 15
1865.....	6076	92 5	1881....	14,735	92 1 ½
1866.....	5300	82 6	1882....	15,974	£86 10s. to £114 10s
1867.....	7069	88 0	1883....	21,306	82 10 to 98 10
1868.....	6300	93 8	1884....	22,467	73 5 to 84 5
1869.....	5442	126 3	1885....	21,069	74 0 to 97 0
1870.....	6043	124 2	1886....	23,625	91 5 to 103 0
1871.....	9100	133 6	1887....	24,185	100 10 to 167 0
1872.....	9600	145 11¾	1888....	25,594	75 0 to 168 10
1873.....	6800	133 3	1889....	32,574	89 0 to 98 5
1874.....	7149	98 6	1890....	31,976	93 0 to 105 0
1875.....	11,000	86	1891....	31,339	

PRODUCTION AND PRICES OF BANCA AND BILLITON TIN.

As a rule the prices of Banca and Billiton tin are those of the sales of these tins in Holland and Batavia. The prices given below, however, are London prices.

Production of Banca and Billiton Tin 1855 to 1891, and Prices of the same.

Year.	Banca.	Billiton	Average Price Banca.	Year.	Banca.	Billiton.	Average Price Banca.
1855...	4233	97		1874...	4930	4032	102 5
1856...	6643	238		1875...	4374	3968	
1857...	4928	130	140 7 0	1876...	4519	3643	
1858...	6367	320	117 7 0	1877...	4324	3000	
1859...	6005	164	136 1 0	1878...	4064	3970	64 2½
1860...	5465	284	136 6 0	1879...	4253	4513	74 2
1861...	5709	462	122 9 0	1880...	3638	4735	89 11
1862...	4678	361	110 5 0	1881...	4339	4740	96 0½
1863...	6334	732	124 2	1882...	4400	4200	
1864...	5343	794	107 8	1883...	4314	4157	
1865...	4554	1065	95 10	1884...	4193	3600	
1866...	4234	1171	85 2	1885...	4371	3760	
1867...	4639	2341	91 7	1886...	4346	4128	
1868...	3960	2151	95 2	1887...	4317	4978	
1869...	4483	2424	128 6	1888...	42 3	5220	
1870...	4672	28 8	126 8	1889...	4377	4857	
1871...	4320	3190	135 2	1890...	5164	5600	
1872...	4352	3456	153 0	1891...	5346	5600	
1873...	4480	3264	135 3				

Australian Tin.

Australian tin first became a factor in the markets of the world in 1873, though some tin was mined in 1872. In the latter year the production was very small, New South Wales smelting but 62 tons and raising 1032 tons of ore in addition. In 1874 the production of this colony had reached 5095 tons of tin and 972 tons of ore. Queensland, which began smelting in 1873, produced in the same year 1208 tons of tin and 4494 tons of ore, and Tasmania, which produced four tons of tin and ore in 1873, produced 143 tons in 1874.

All the mining that has yet been done in Australia is alluvial, though the deposits lie differently from those of the Straits. At Banca and the Straits the placers are worked by stripping the superincumbent drift. In Australia the tin-bearing deposit is so far below the surface that shafts are used in some cases.

The matrix of this tin stone is the granite range of the eastern coast of Australia. In Queensland most of the workings are surface. In New South Wales shafts are sunk in the beds of ancient rivers. On Vegetable Creek a shaft is sunk through 90 feet of basalt and a thin bed of pipe clay to the sands and gravels of the ancient river bed in which the tin is found. These stanniferous sands and gravels are 15 feet thick above water level. How far they extend below is not known, as workings are abandoned when water is reached.

PRODUCTION OF TIN IN AUSTRALIA.

There is some uncertainty as to the total production of tin in the Australian colonies by reason of the fact that considerable tin is sent from one colony to another, and in the statements of exports which are to so large an extent the basis for arriving at production, this tin may be reported twice. There is also a great difference in the production reported by different authorities. In the *Mines and Mineral Statistics* of New South Wales, 1875, the production of tin in 1874 in that colony is stated to be 4101 tons, and 2818 tons of tin ore in addition. In the reports of the British Board of Trade the production is given as 101,892 cwt. (5,095 tons) of tin and 19,444 cwt. of tin ore. I have taken, so far as they could be obtained, the figures of the British Board of Trade and the Mineral Statistics of the colonies.

QUEENSLAND TIN DEPOSITS.

The stanniferous country of Queensland lies between the headwaters of the Condamine river on the north and the boundary of the colony on the south, and comprises about 550 square miles, of which about one-half has been proved sufficiently rich to pay for working. It is along the course of the river Severn from near its source down to Ballandean, a distance of 140 miles, that the principal alluvial deposits are found. The richest deposits lie in the stream bed and on the flat banks on both sides of the river. The quantity of tin ore reaches as high as 30 tons to the chain (66 feet), and its average is 10 tons per chain.

PRODUCTION OF TIN IN QUEENSLAND.

There is no little difficulty in securing accurate statements of the productien of tin in all of the Australian colonies owing to a confounding in the published statististics of tin and tin ore. The exports are reported in many cases as tin and tin ore. In some cases, at least, the "tin" is not tons of metallic tin, but tons of ore exported as metallic tin. Due allowance should be made for this.

In the following table are given the number of tons of tin ore exported from Queensland as tin ore, and the tin ore equivalent of the metallic tin exported from 1872 to 1889:

Production of Tin in Queensland, 1872 to 1889.

Year.	Ore Exported as Tin.	Ore Exported As Ore.	Year.	Ore Exported as Tin.	Ore Exported As Ore.
	Tons.	Tons.		Tons.	Tons.
1872...	0	1334	1881.....	479	2977
1873...	232	4916	1882.....	589	3673
1874...	1208	4-91	1883.....	681	4253
1875...	589	3885	1884.....	314	3864
1876...	296	4089	1885.....	257	2584
1877...	168	3167	1886.....	1462	2011
1878...	210	2496			
1879...	329	2513	1887.....	3297	
1880...	430	2417	1888.....	3586	
			1889.....	3033	
			1890.....	......	

The yield of ore would be 65 to 70 per cent metallic tin.

The following table, from the Mineral Statistics of Queensland, gives exports and values, 1880 to 1889.

Tin Ore exported from and raised in Queensland from 1880 to 1889.

Year.	Tin Ore Exported.				Tin Ore Prod'c'd	
	As Ore.		Smelted.			
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	cwt.	£	cwt	£	Tons.	£
1880...	48 349	107,043	8,595	35,9[illegible]7	2,847	142,977
1881...	5[illegible],54[illegible]	147,605	9,583	46,[illegible]94	3 456	193,699
1882...	73,450	209 091	1[illegible],778	60,813	4,261	269,904
1883...	85 0[illegible]2	288,355	11 629	60,490	3,346	187,292
1884...	77,283	204,163	6,277	24,294	3,3[illegible]3	13[illegible],4[illegible]0
1885...	51,677	139,411	5 138	17,336	3,[illegible]53	1[illegible]1 871
1886...	40,217	84,927	29,247	107,637	3,153	162 124
1887...	....	....	....	....	3,[illegible]97	217,389
1888...	....	....	....	....	3,586	200 [illegible]19
1889...	....	....	....	....	3,033	156,466

VICTORIA TIN DEPOSITS.

Going southward tin is found in Victoria near the boundaries of the granite masses of Beechworth and Berwick in the county of Mornington. In the granite and alluvial deposits surrounding these granite masses tin ores, often associated with gold, are found. Indeed, some tin has been produced in this colony almost from the beginning of the working of the gold fields.

PRODUCTION OF TIN IN VICTORIA.

In the following table are given the exports and production of tin and tin ore in Victoria from the discovery of the gold fields to December 31, 1870:

Tin and Tin Ore Exported from and Raised in Victoria from Discovery of Gold Fields to December 31, 1890.

Year.	Tin Ore.		Tin.	
	Quantity.	Value.	Quantity	Value.
	Tons.	£	Tons.	£
1867 (1).........	2601	192,926	...	......
1868.........	92	6,471	4	510
1869.........	178	9,318	8	7[illegible]9
1870.........	269	17,551	cwt. 14	98
1871.........	147	9,524	cwt. 15	157
1872.........	250	17,500	8	1,097
1873.........	295	20,775	42	5,439
1874.........	175	11,301	49	5 760
1875.........	113	6,720	38	3,628
1876.........	15	714	52	4,084
1877.........	62	2,836	34	2,521
1878.........	75	3,083	3	215
1879.........	35	1,515	5	251
1880.........	36	1 947	2	216
1881.........	34	1,506	cwt. 16	68
1882.........	19	445	cwt. 3	15
1883.........	16	463	58	5,113
1884.........	42	1,647	11	812
1885.........	9	360	47	3,784
1886.........	4	105	13	1,245
1887.........	12	580	...	......
1888.........	13	610	...	......
1889.........	13	368	25	2,316
1890.........	18	362	15	1,375

(1) Data not obtainable in detail prior to 1867. This gives total to the end of 1867.

PRODUCTION OF TIN IN SOUTH AUSTRALIA.

The only figures of production in South Auatralia that I have been able to obtain are that 180 cwts. of tin, valued at £360, were exported in 1883, and 196 cwts., valued at £34, in 1890. In 1885 40 cwts. of tin ore, valued £107, were exported, and in 1887 100 cwts., valued at £160.

NEW SOUTH WALES TIN DEPOSITS.

The same geological conditions exist in New South Wales as in Queensland. It is from the disintegration of the micaceous and feldspathic dykes that traverse the granite of the ranges that the rich alluvial deposits of tin are derived. These deposits are found in the low-lying lands and along the banks of the streams. With this tin are found fragments, more or less worn, of the original enclosing rock. Lumps of nearly pure ore in all sizes up to 50 pounds are found.

PRODUCTION OF TIN IN NEW SOUTH WALES.

In the following table is given the production of tin and exports of tin ore in New South Wales, 1872 to 1890.

Production of Tin in New South Wales from the opening of the tin fields in 1872 to 1890.

Year.	Ingots.		Ore.	
	Quantity.	Value.	Quantity.	Value.
	Tons.	£	Tons.	£
1872.........	47	6,482	849	41,337
1873.........	911	107,7[illegible]5	3660	226,641
1874.........	4101	366,189	2118	118,133
1875.........	6058	475,168	20[illegible]2	86,143
1876.........	5449	379,318	1509	60,320
1877.........	7230	47[illegible],952	824	30,588
1878.........	6085	362,062	1125	33,750
1879.........	5107	343,0[illegible]5	814	29,274
1880.........	5476	440,615	682	30.722
1881.........	7591	686,511	609	37,492
1882.........	8059	800,571	611	3[illegible],890
1883.........	8680	802,867	445	21,685
1884.........	6316	5[illegible]6,726	350	14,861
1885.........	4658	390,458	535	25,168
1886.........	4641	44[illegible],303	327	18,3[illegible]0
1887.........	46[illegible]9	509,0[illegible]9	292	16,411
1888.........	4[illegible]62	569,182	247	13,314
1889.........	4650	415,171	....	....
1890.........	3668	32[illegible],841	.....	....

TASMANIA TIN ORE.

Further south tin has been found at Mount Bischoff. Veins and strings of tin traverse the rocks of this mountain, and tin ore occurs in the joints. From the disintegration and denudation of these rocks tin ore fills the troughs and hollows of the mountain side; hence the hill has been called a mountain of tin ore. Similar discoveries have been made in other parts of the island.

PRODUCTION OF TIN ORE IN TASMANIA.

The following statement of production in this colony is the best obtainable, though it is evident that tin and tin ore have been confounded:

Exports of Tin from Tasmania, 1873 to 1889.

Years.	Tin.	Tin Ore.	Value.
	Quantity.	Quantity.	
	Tons.	Tons.	£
1873.........	4		....
1874.........	142		....
1875.........	366		....
1876.........	1616		....
1877.........	5747		....
1878.........	5947		....
1879.........	4563		....
1880.........	3951	3	341,736
1881.........	4120	4	375,775
1882.........	3589	81	361,046
1883.........	4045	77	376,446
1884.........	3675	32	301,423
1885.........	4242	...	357,587
1886.........	3776	...	363,364
1887.........	3606	1	407,857
1888.........	3775	...	426,321
1889.........	3764	...	34[illegible],941

Tin in Bolivia.

But little has been learned about the deposits of Bolivia, but its tin is assuming some importance in the world's markets, as is evidenced by the fact that it is associated with the product of Cornwall, Banca, Billiton and the Straits in the yearly report of production, while the older deposits of Spain, Saxony, etc., are not. The figures of production, given below, are those of certain English dealers who published annual reviews of the tin market. These figures are much below those of the Bolivian consul at New York, who states that Bolivia has exported to England 5000 tons of tin ore per annum for the last ten years.

Estimated Production of Metallic Tin in Bolivia, 1880 to 1891.

	Tons, 2240 lb.		Tons, 1240 lb.
1880.........	360	1886.........	900
1881.........	300	1887.........	1000
1882.........	350	1888.........	1500
1883.........	400	1889.........	1500
1884.........	150	1890.........	1800
1885.........	300	1891.........	1800

Tin in Austria.

A little tin has been found in Austria in Galicia, and that of but little importance. Most of the tin of Austria-Hungary, which in its total is but a small part of the world's supply, comes from Bohemia from the great tin deposits of the Erzgeberge range of mountains which form the boundary between Saxony and Bohemia. The deposits are similar to those at Altenberg (Fig. 2).

No very recent figures of production of tin in Austria-Hungary have been secured. In 1881 the production was 10,514 metric centines; in 1882, 26,019; in 1883, 27,308; in 1884, 9514; in 1885, 10,996; in 1886, 3895.

Tin in Germany.

The chief tin mines of Germany are on the Saxon side of the Erzgeberge at Altenberg (Fig. 2), and Geyer. The Zinwald deposit is partly in Bohemia.

At Altenberg the beds are traversed by a network of fine flexuous veins which vary from one to several feet wide. All of these through their course in rock 2 (Fig. 2), are more or less charged with tin. At Geyer the tin stone is in small veins, rarely more than 2 inches wide. At Zinwald the tin stone occurs in granite.

Tin production has not been a very important industry in Germany of late years.

Spanish Tin.

As has already been stated, it has been known for many centuries that tin existed in Spain, but its product has never had any effect upon the market. The following indicates the production:

1864......... 626 Metric Quinteaux.
1865......... 930 "
1866......... 301 "
1890......... 48 Metric Tons.

Minor Tin Localities.

Attempts have been made to work the tin deposits near Auvergne in Central France, where there are traces of ancient mining operations, but without success.

In Sweden a small amount of tin ore, 200 tons according to one authority, is raised yearly.

In Italy a few tons of metallic tin are produced annually.

Russia, it is stated, produced 150 to 200 tons of tin in a year.

Considerable tin has been mined in Peru. In 1868 this country sent 1500 tons tin ore to England, but the production is now some 100 to 200 tons metallic tin a year.

Production of Tin in the United States.

The only metallic tin produced in the United States in commercial quantities has been from the Temescal mines in San Bernardino county in the southern part of California. Considerable ore has been mined at Harney's Peak and is on the dumps awaiting the erection of machinery and plant for dressing and smelting, and there are promising developments on Irish Creek and in its vicinity in Rockbridge county, Virginia; but as stated, the only metallic tin yet produced in a commercial way is from the Temescal mines, 62 tons having been produced and sold from June 1, 1891, to December 31, 1891. The output is increasing rapidly as the mines are opened and the dressing and smelting plant gets in good working order.

Of the 62 tons metallic tin produced in the seven months of 1891, the product of December was 40,840 pounds. The product of January, 1892, was several thousand pounds in excess of this.

Temescal Mines and Reduction Works.

The Temescal mines, or as they are known by their proprietors, the San Jacinto mines, which are at the present time the only ones in the United States from whose ore metallic tin is being produced, are located on the famous San Jacinto estate in San Bernardino county in Southern California, some 6½ miles from South Riverside.

TIN VEINS AT TEMESCAL.

The tin lode, for the mining here is vein work and not placer, is in granite and has been known for many years. In 1861 considerable exploration was done on the lode now being worked, which is known as Cajalco. The vein outcrops on the hillside, as will be seen from the accompanying illustration, and

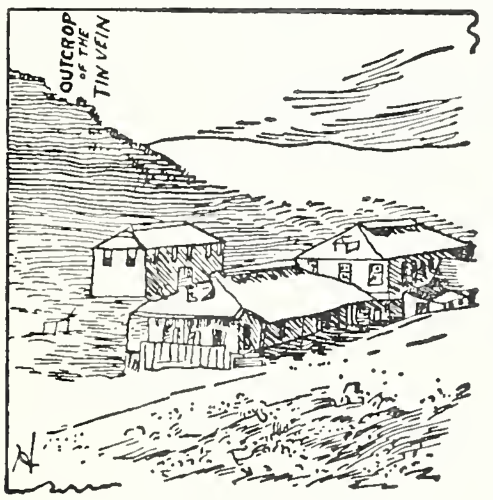


FIG. 10. Camp and Outcrop of Ore.

traverses the granite in a northeasterly and southwesterly direction. Though but one vein is worked at present, a large number of others have been traced, so the owners claim, that can be followed for a mile or more. These veins are from 3 to 5 feet wide, clearly and sharply defined, the vein matter yielding 2½ to 7 per cent of cassiterite.

The main shaft on the Cajalco lead is 182 feet deep and is worked from two levels. Two other shafts are being sunk and preparations being made to greatly increase the output.

CONCENTRATING MACHINERY AT TEMESCAL.

The concentrating and reduction plant consists of a 5-stamp mill, two pneumatic crushers with a capacity of 24 stamps each, a concentrating table or vanner, and a reverberatory tin smelting furnace. The hoisting and reduction works are shown in the accompanying illustration.

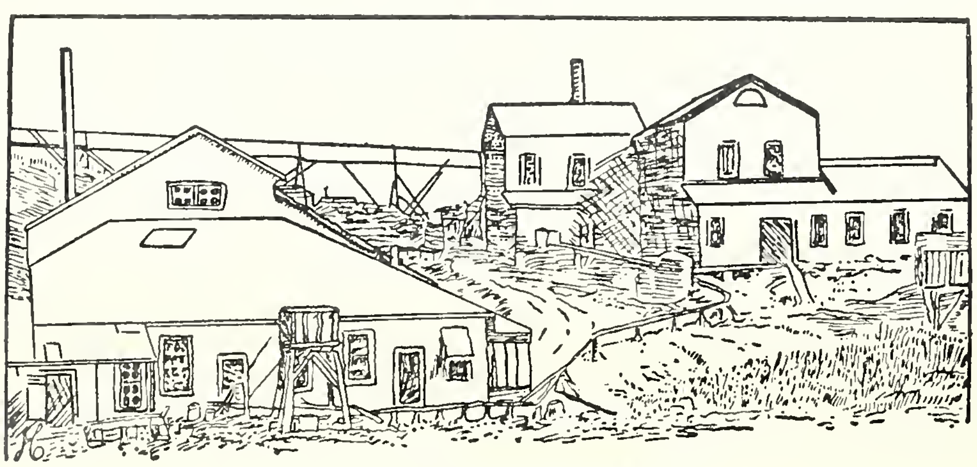


FIG. 11. Hoisting and Reduction Works.

AMERICAN CONCENTRATORS OR VANNERS.

In dressing the ore, as arsenic seems to be absent, there is no preliminary burning. The tin rock, which is mica and quartz, is crushed in the stamp mill to the fineness of flour. The separation of the black tin from this crushed tin rock is by means of a vanner or concentrator of Amrican design and construction. It consists of long inclined tables over which run endless belts of rubber. The whole table is shaken rapidly sidewise to make the heavy black tin settle down on the rubber, which is ever moving up grade, carrying the tin with it. A spray of water washes the lighter quartz, iron and other ingredients down the grade and out of the way. The "headings" is the cassiterite or black tin.

TIN SMELTING WITH PETROLEUM.

The smelting is done in reverberatory furnaces using petroleum as fuel. Coal is very scarce and high, most of that used in the section of California in which these veins are located being from Australia, worth from $12 to $16 a ton. The California petroleum fields are in close proximity to the tin mines, the oil being worth about $2 a barrel and three barrels equaling in fuel value a ton of coal. The result was that the tin furnaces were built with a view to using petroleum as fuel. This has resulted in delays and no end of annoyance, but the problem seems to have been solved.

TIN SMELTING IN BLAST FURNACES.

As is stated elsewhere, the early practice in smelting tin was to use a small blast fur nace, such as is herewith illustrated:

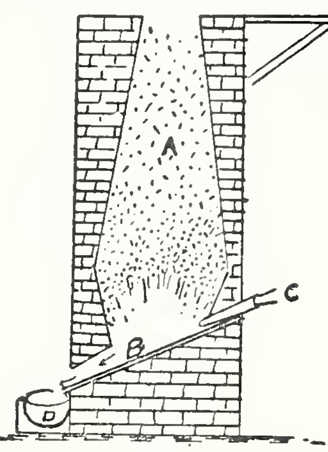


FIG. 12. Old Style Tin Furnace.

A—Ore charge. B—Hearth. C—Air Blast. D—Dipping Pot.

The furnaces formerly used in Cornwall were but 6 feet high from the hearth to the throat. In the Erzgebirge, in Saxony, the furnace which was employed until recently, if it is not still used, was 10 feet high. The construction will be apparent from the cut. Charcoal was used as fuel; the furnace was constantly charged, the process being continuous, the molten metal and slag running into the dipping pot D, from which tin was run to other pots for refining with green wood, and the slag taken away and cooled for after treatment. This blast furnace method is but little used. It was costly and wasted the tin.

TIN SMELTING IN A REVERBERATORY AT TEMESCAL WITH PETROLEUM.

A reverberatory furnace, somewhat similar in general construction to those of Cornwall, is used at Temescal mines. The former has been modified somewhat to adapt it to use petroleum. The general form is as shown in the accompanying longitudinal elevation:

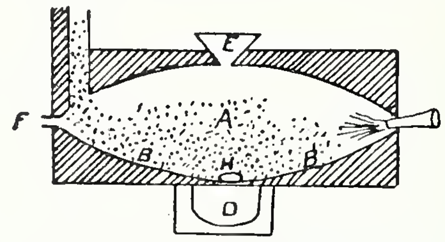


FIG. 13. Temescal Tin Furnace.

A—Ore charges. B—Hearth. C—Crude petroleum blowpipe flame. D—Dipping pot. E—Ore-feeding hopper. F—Door for stirring charge while melting. G—Chimney. H—Hole for tin to run out.

No description of the process which is similar to that used in Cornwall which is shown in connection with the discussion of tin smelting in Cornwall need be given. The furnace is heated with oil. While this is regulated with comparative ease and overheating and consequent waste avoided, the oil flame, which is driven by steam blast, has proven damaging to the fire brick lining, requiring frequent renewals.

PRODUCTION OF TEMESCAL TIN.

The production of tin at the Temescal mines has been quite small owing to the fact that much of the machinery and the fuel used were unfamiliar to the workmen. Shipments began in June, most of the tin being sent to W. W. Stewart & Co., of San Diego, who are the agents. These gentlemen write that the production in 1891 was 62 tons. By months the shipments to San Diego have been as follows in pounds:

Shipments of Temescal Tin to San Diego, 1891.

June	11,280
July	8,180
August	14,071
September	13,000
October	17,875
November	15,420
December	40,840
	120 666

Shipments to San Francisco direct were sufficient to bring up the total to the 62 tons given as the production.

Black Hills or Harney Peak Tin.

EXTENT OF HARNEY PEAK DISTRICT.

The tin-bearing rocks of this district are partly in South Dakota and partly in Wyoming. The area begins in the extreme southwestern portion of the former state, in that mountainous country enclosed by the North and South Forks of the Big Cheyenne, and in the Black Hills or Harney Peak region, and extends into Wyoming.

TIN VEINS GOLD-BEARING.

The tin veins are gold-bearing, as are those of Victoria. The miners of this section, which has been worked for gold since 1875, have always been troubled with a black sand which filled the riffles of their sluice boxes to such an extent as to become a positive nuisance. It was called "iron," the practical miners never suspecting that it was tin stone until the discovery of tin at the Etta mine.

THE HARNEY PEAK TIN VEINS.

But little stream tin has been found. Prof. T. B. Carpenter suggests that the reason of this is that but little gulch mining has been done in the Harney Peak region. The ore veins are classed by Prof. Carpenter as tin veins of the seggegated type. The line of demarcation between the granite vein matter and the enclosing schists is marked. The deposits vary greatly in breadth, being sometimes a few inches, at others 100 feet. The amount of ore varies. It is never distributed through the vein from wall to wall, but lies in zones or sheets. Nearly always when tin is present one of the constituents of granite is wanting. When all three elements of granite are present tin is apt to be absent. The crys-

tals of cassiterite usually partake of the nature of the crystals of the enclosing rock. If they are large so are the crystals of cassiterite. It is not possible here to fully describe this interesting section. Those desiring further information are referred to Prof. Carpenter's paper in the Transactions of the American Institute of Mining Engineers.

YIELD OF BLACK HILLS ORE.

This ore has never been worked on a commercial scale, though quite large amounts, as much in one case as 80,000 pounds, taken from various mines, were sent to England to be analyzed and treated. The metallic tin ran from 2.28 lb. per ton to 248.77 lb., 69 samples being analyzed.

A portion of this shipment amounting to 10 T 3 cwt. was subjected to a "mill run." An average sample was drawn from the bulk after crushing and mixing, which was analyzed and found to contain 2.94 per cent of metallic tin or 65.85 lb. of metal per ton of tin stuff equal to 83.7 lb. tin oxide or ore. Several experiments were made in actually concentrating the ore, the yield being 2.60 per cent metal as against 2.94 per cent found by analysis.

PRODUCTION OF TIN ORE AT HARNEY PEAK.

No metallic tin has been produced from the Harney Peak ore on a commercial scale. The small amounts that have been smelted have been as tests. Quite a number of mines have been opened, shafts sunk, some ore produced. Considerable tin stuff is in sight, and a concentrating plant is being erected.

In August 1891 5 mines had been opened. The "Addie" mine was down 300 feet with a well timbered 3-compartment shaft with drifts 60 to 170 feet long from the 90, 135 and 200 foot levels. The "pay chute" opened was stated to be 250 feet long, 200 feet deep, 8 feet wide on an average, the tin stuff averaging about 2 per cent of metallic tin, 2000 tons of ore were on the dump. The shafts at the other mines were down various depths, one 310 feet, and all showing ore carrying from 1 to 6 per cent metallic tin, there being some 8000 tons of ore on the dumps.

THE FUTURE OF HARNEY PEAK TIN.

An impression is abroad that the mining of tin at Harneys Peak is destined to be a failure, the opinion being based upon a belief that there is but little tin ore in this district. The facts hardly warrant this conclusion. The experts who have examined this region are too well known, and some of them have too high a reputation for honesty and ability to allow of a belief that they have either been deceived or are deceiving the public. No doubt there is tin ore in large quantities in this district. Mines are opened, shafts sunk, entries made at different levels; and last August it was estimated that 60,000 tons of ore was in sight in addition to some 8000 tons on the dumps. At 65 lb. of metallic tin to the ton of ore, this would equal 4,420,000 pounds of tin. The first half section of a 500-ton mill was being erected last August, and the ore in sight at that time would run this mill some 250 days.

Whether tin mining and smelting at Harney Peak can be made a commercial success remains to be seen. The author of the report from which we have copied seems to think they can. It will be a severe struggle between stream tin and Chinese labor on one hand, and vein tin and American labor saving machinery on the other.

The Irish Creek (Va.) Tin Deposits.

As is stated elsewhere, it is reported that a quantity of tin stuff was mined on Irish creek, in Rockbridge county, Va., in 1891. Of this a portion was concentrated, how much is not stated, and some 2000 tons of the tin stuff remained on the dump. The work done has been largely in the nature of explorations, the parties mining having an option to buy, which expires early in 1892, and which, it is reported, they propose to exercise.

These developments are on and near Irish creek, in the eastern part of Rockbridge county, Va., near the line of the Shenandoah Valley portion of the Norfolk and Western railroad. The area of the field is small, though the extent has not been fully developed.

The veins resemble those of Cornwall and other tin-producing districts. There are the same crystalline and metamorphic rocks, broken, fissured, and the same traversing veins of tin stuff. The region has been thoroughly tested, and if reports received are true this section has a future as a tin producer.

The World's Production of Tin.

For reasons already stated it is well nigh impossible to state accurately the world's production of tin. The figures usually given with some exceptions are those of exports or imports into Europe and the United States. The home consumption of Australia, the exports from Singapore and Penang to China and Japan are not always included in statements of production of the Straits. The Banca and Billiton figures are of sales in Holland and Batavia respectively, while exports of metallic tin and tin ore are often confounded.

In the following table is given the best information obtainable, and for the latest year as to the production of tin and tin ore in the world. In many cases these are estimates but based on fairly accurate information:

The World's Production of Tin.

Country.	Date.	Tin. Tons 2240.
Cornwall	1890	9,602 [1]
Banca	1891	5,346
Billiton	1891	5,600
Straits:		
England and U. S. & Continent	1891	31,339
China and Japan	1891	3,000 [1]
Australia [3]:		
Queensland [2]	1889	2,022
New South Wales	1890	3,668
Victoria [2]	1890	27
Tasmania [2]	1890	3,764
South Australia [2]	1890	10
Boliva	1891	2,000 [1]
Peru	1891	200 [1]
Germany [4]	1890	100 [1]
Austria-Hungary [4]	1890	430
Spain	1890	48
Italy	various	10 [1]
Sweden	various	200 [1]
Russia	1885	606
United States	1891	310 [5]
Chili	1890	1541
Japan	1888	140
Total		69,963

[1] Estimated. [2] Tin ore is reduced to its equivalent in metallic tin on the basis of a yield of $66\frac{2}{3}$ per cent. [3] In 1891 5225 tons were produced. [4] This is Kerl's estimate. Of this 60 tons was metallic tin, the remainder tin ore reduced as per note [2].

Imports of Tin Into the United States.

In the following table, furnished by the Bureau of Statistics of the United States Treasury Department, is given the imports of tin in bars, blocks and pigs into the United States for the calendar ye r, 1867 to 1891:

Imports of Tin into the United States 1867 to 1891 Calendar Years. Tons 2240 lb.

Year.	Quantity. Tons.	Year.	Quantity. Tons.
1867	10,575	1880	13,346
1868	4,732	1881	9,168
1869	3,901	1882	0,597
1870	4,535	1883	12,558
1871	6,067	18[illegible]4	11,252
1872	5,503	188[illegible]	10,50
1873	4,948	1886	13,184
1874	5,653	1887	13,100
1875	4,891	1888	13,310
1876	4,849	1889	15,704
1877	6,022	1890	15,099
1878	5 830	1891	18 368
1879	10,186		

Prices of Tin in New York.

In the following tables are given the cash prices of spot tin (Straits) in New York for 1891 by months, and the highest, lowest and average prices for 11 years:

Highest, Lowest and Average Prices of Spot Tin (Straits) in the New York Market in 1891 by Months.

MONTH.	Highest. Per lb. Cents.	Lowest. Per lb. Cents.	Average. Per lb. Cents.
January	20.25	20.00	20.15
February	20.10	19.80	19.90
March	[illegible]0.30	19.75	20.05
April	20.40	[2]19.40	19.90
May	20.45	19.75	20.20
June	[1]21.	20.20	20.65
July	20.70	20.15	20.40
August	20.20	19.85	20.
September	20.15	19.95	20.05
October	20.20	19.85	20.05
November	20.15	19.65	19.90
December	20.00	19.80	19.90

[1] On June 8th. [2] On April 20th and 23d.

Highest, Lowest and Average Prices of Spot Tin (Straits) in the New York Market 1881 to 1891. Cents Per lb.

YEAR.	Highest. Per lb. Cents.	Lowest. Per lb. Cents.	Average. Per lb. Cents.
1881	$24\frac{3}{8}$	19.75	$20\frac{3}{4}$
1882	$25\frac{1}{4}$	20.50	$23\frac{1}{2}$
1883	[illegible]$2\frac{1}{8}$	18.50	20.75
1884	19.70	16.00	18.10
1885	23.25	16.10	19.50
1886	23.15	20.35	21.55
1887	37.25	21.90	24 85
1888	37.25	16.90	26.20
1889	22.25	19.50	20 85
1890	25.10	19.50	21.15
1891	21.00	19.40	20.10
For the 11 years above	$37\frac{1}{4}$	16.00	21.55

Commercial Supply of Tin.

As is stated above most of the statistics of tin are of shipments to the United States, Great Britain and the Continent of Europe, and the production of Cornwall, and only embrace the figures for Cornwall, Banca, Billiton, the Straits, Australia and in recent years Bolivia. While those figures do not give the world's production or consumption they have a value. We give these statements as showing supply in the United States, Great Britain and Europe for the years 1860 to 1891.

Shipments of Tin to the United States, Great Britain and Europe from the Undermentioned Countries, 1860 to 1891, Tons 2240 lb.

Locality.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.
Cornwall	6,695	7,450	8,476	10,006	10,108	10,039	9,990	8,700	9,300	9,760	10,200	10,900	9,560	9,972	9,942	9,61[illegible]
Banca	5,465	5,709	4,678	6,3 4	5,3[illegible]3	4,554	4,234	4,639	3,960	4,483	4,672	4,320	4,352	4,480	4,930	4,374
Billiton	284	462	361	732	794	1,[illegible]65	1,171	2,341	2,151	2,424	2,858	3,190	3,456	3,264	4,032	3,96[illegible]
Straits	4,529	4,343	3,931	3,060	4,364	6,076	5,300	7,069	6,300	5,442	6,043	9,100	9,600	6,800	7,149	11,000
Australian	....	....	....	....	....	....	....	[2]2,601	66	127	180	100	1,677	7,025	5,574	10,746
Bolivia	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Total	16,973	17,964	17,146	20,132	20,609	21,734	20,695	25,350	21,777	22,236	23,953	27,610	28,645	31,541	31,627	39,702

Locality.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
Cornwall	8,500	9,500	10,106	9,532	8,918	8,615	9,158	9,307	9.574	9,331	9,312	9,[illegible]82	9,241	8,912	9,602	[1]9,600
Banca	4,519	4,324	4,064	4,253	3,6[illegible]8	4 339	4,400	4,314	4,19[illegible]	4,371	4,346	4,317	4,253	4,377	5, 64	5,346
Billiton	3.643	3,000	3,970	4,513	4,735	4,74	4,200	4,157	3,6 [illegible]	3,760	4,12[illegible]	4,97[illegible]	5,220	4,[illegible]57	[1]5,600	[1]5 600
Straits	9,521	3,014	8,000	10,985	14,763	14,735	15,974	21,306	22,467	[illegible]1,069	23,625	24,185	25,594	32,574	31,976	31,339
Australian	10,517	13,910	12,656	10,614	9,149	10,[illegible]84	0.120	10,625	8,835	8,498	7,505	7,016	7,100	6,125	5,718	5,22[illegible]
Bolivia	....	....	....	....	300	380	350	400	400	150	300	900	1,000	1,500	1,800	1,800
Total	36,700	33,748	38,796	39,897	41,503	42,813	44,202	50,109	48,669	47,179	49,216	50,678	52,408	58,345	59,855	58,910

[1] Estimated. [2] This includes all the production of Victoria prior to and including 1867.

TIN PLATE.

Its History, Manufacture and Statistics.

By JOS. D. WEEKS.

What is Tin Plate?

TIN PLATE.

Tin plate, or to speak more accurately, *tinned plate* or *tinned sheets*, is thin sheets or plates of iron or steel coated with tin..

TERNE PLATE.

Terne plate is sheet or plate iron or steel, covered with an alloy of tin and lead, usually two-thirds lead and one-third tin. It is this union of the three metals, iron, lead and tin, that gives rise to the name terne plate, *terne* being the French equivalent of the English adjective tern, meaning threefold. The oft repeated statement that terne is from a French word meaning dull is incorrect. Terne plate, because of the presence of lead in the coating, is duller than tin plate, which is frequently called *bright plate*, but it is not this fact that gave rise to the appelation terne, but the union of the three metals.

TAGGERS TIN.

Taggers tin is a thin tin plate, 30-wire gauge and lighter. This name is not applied, as is often stated, because the iron out of which the plate is made was at one time, and is even now, used for tags or marks. The term was originally used to designate the very thin sheet iron which ran below the gauge—"tagged on" to the regular gauge—and hence these thin sheets tinned are called "taggers tin."

TIN ALLOYED WITH THE IRON.

There is a question as to whether the tin used forms an alloy with the iron or is only a simple coating. It seems to be more firmly attached to the iron than a mere coating would be, rarely if ever, when the sheet is properly prepared, scaling off, but requiring absolute rubbing away to remove it. It is probable that the tin coating forms an alloy with the iron.

SIZES, WEIGHTS, ETC.

The plates thus coated form the well known tin and terne plates of commerce, the sheets varying greatly in size, from 10"x14" to 40"-x84"; in gauge of plate from 22 to 30 for tin and terne plate, and 30 to 38 for taggers; put up in boxes containing 14 to 225 sheets and varying from 7¼ lb. to 400 lb. a box. The standard size of tin plate is I C coke plate 10"x14", with 225 sheets to a box, and weighnominally 108 lb. to a box. Complete statements as to weights, number of plates to a box, etc., are given elsewhere.

Definitions.

Tin plate is thin sheets of iron or steel 22 w. g. to 30 w. g., coated with tin. It is called also *bright tin*, *tinned sheets*, *tinned plate*. The French name is *fer blanc* or *white iron*, a name that was at one time used in England.

Taggers tin is very thin tin plate 30 w. g. and lighter.

Terne plate is sheets of iron or steel coated with tin and lead. The proportions of these two metals and the consequent quality of the terne plates vary greatly; the more lead the inferior the plate. *Roofing, plates* from their almost exclusive use for this purpose; *Canada plates*, from their extensive use for roofing in that country, are other names for ternes.

Charcoal plates are tin plates, the iron plates of which were made of charcoal iron. But few charcoal plates are now made.

Coke plates are tin or terne plates made from puddled iron plates.

Bessemer plates, Siemens plates, open-hearth plates indicate the kind of steel out of which the plates are made.

A mender or *return* is an imperfect plate returned to the tin house to be mended or repaired.

Wasters are imperfect plates sold as such.

Black plate is the iron or steel plates or sheets as they come from the rolling mill having been cut to the proper size. They are termed *black pickled plates* after the first pickling or immersion in dilute acid. *Cold rolled* plates, after cold rolling. *White pickled plates*, after the second pickling and when they are ready for the tin pot.

History of Tin Plate.

EARLY TINNING.

What is known of the history of tin plate is an oft told and well known story. It seems quite certain that vessels were coated with tin as early as the beginning of the Christian era, but whether they were of copper or iron is a matter of some doubt. The vessels were tinned probably by being immersed in the molten metal. Articles of iron, as horse's bits, etc., were also tinned before tin plate was made.

TIN PLATE FIRST MADE IN BOHEMIA.

All accounts as to the early manufacture of what we now know as tin-plates agree that they were first made in Bohemia, the tin from Erzgebirge being used in their production.

If this latter supposition is correct then the manufacture could not have existed prior to 1240, at which time these tin mines were discovered, as has already been narrated, by a Cornish miner.

Up to 1620 there is no record of tin plates having been made outside of Bohemia, and the Bohemians supplied the world with plates and had done so for many years prior to this date.

ESTABLISHMENT OF SAXON MANUFACTORIES.

In 1620 the reigning duke of Saxony made an effort to learn the secret of the manufacture of tin plate that he might establish it among his people. He was successful, and when Yarranton, who brought the secret to England, visited Saxony in 1665, he found quite a number of works in operation and the trade well established. Yarranton stated that at that time 80,000 people were dependent for support upon the tin plate industry. He must have included all who were supported directly or indirectly. No record is given of the details of the manufacture of tin plates at this time.

INTRODUCTION OF TIN PLATE MANUFACTURE INTO ENGLAND.

The story of the introduction of tin plate manufacture into England is almost a repetition of that of other important industries. A journey to the continent where the industry was established, the discovery of the secret, the return to England with high hopes to found a profitable business, a series of dissappointments, sometimes of utter failure, while others reaped the reward, or at least prevented the one who had done the work, from obtaining the benefit to which he was entitled.

YARRANTON GOES TO SAXONY.

In 1665, Mr. Andrew Yarranton, with a workman started for Saxony to learn the secrect of making tin plates that he might establish their manufacture in England. They were well received, allowed to inspect and study the materials and methods used, returned to England and made some plates in an experimental way in 1670 at Pontypool in Monmouthshire, which were pronounced better and more pliable than those made in Saxony.

YARRANTON'S FAILURE.

Yarranton immediately began preparations to manufacture the plates on a commercial scale but knowledge of his success became known, a patent for making plates was granted to others, he was deserted by his ablest partners, the attempt was abandoned and was not resumed until 1720.

HAMBURY'S ESTABLISHMENT OF MANUFACTURE OF TIN PLATE AT PONTYPOOL.

In this year, Major John Hambury, of Pontypool, where Yarranton made his experiments, whose family was engaged in the iron business at and before Yarranton's time, entered into the manufacture of tin plates and succeeded when Yarranton failed. The discovery of sheet iron rolling in 1728, the sheets having been hammered previous to this, greatly advanced the tin plate industry and enabled England not only to compete with Saxony but to excell the German plates. The tin plates made with rolled iron were more pliable and of a more uniform thickness than the hammered plates of the continent.

EARLY FRENCH MANUFACTURE OF TIN PLATE.

Six years prior to the establishment of the manufacture of tin plate at Pontypool the industry had been successfully introduced into France, a works having been started at Mansvaux in Alsace in 1714. Two unsuccessful attempts had previously been made between the years 1650 and 1680, probably as early as Yarranton's unsuccessful attempt at Pontypool. The works at Mansvaux were followed by those at Bains in Lorraine in 1733, Imphy near Nevers in 1745 and Merambeau in Franche Comte in 1751.

Early Methods of Tin Plate Making.

HAMMERED SHEETS.

At first the black plates for tinning were hammered, the tin bar, after being somewhat "flattened" being cut into what was called a "sole" doubled and still further flattened and finally beaten in packs of 50 sheets under a 600 or 700 lb. water driven, slow-moving hammer to the required thickness, or as nearly so as the method employed would permit. The use of rolled plates was introduced into England soon after 1728 and into the works on the Continent at a later date.

PICKLING WITH BARLEY WATER.

Before pickling came into use, about 1747, the sheets were scoured with sand and water, the rough places being filed off and the sheet covered with resin before tinning. The acid for pickling—"gnawing" it was called—was at first water acidulated by the fermentatlon of rye or barley meal. The pickling vats were kept in underground vaults so highly heated that the men worked naked. As the solution was weak the pickling required two or three days, or even longer. Vinegar and also "vitriol" were sometimes used, but they were regarded as too expensive.

ANNEALING WITH CHARCOAL.

The annealing was done by smothering the plates in charcoal. Tallow or grease was used as a cover to the tin bath and before

tin pot rolls were invented the ridge of tin on the lower edge of the sheet was removed by melting the ridge in molten tin and dashing the surplus off by a smart blow on the plate.

Course of Improvements in Tin Plate Making.

In the 170 years since England began the manufacture of tin plates the most important improvements in methods and machinery have been the introduction of sheet rolling in 1728; the use of the grease pot in 1745; the substitution of acids, hydrochloric and sulphuric for barley or rye meal water for pickling in 1760; grooved rolls in 1783; the division of the wash pot into two parts about 1800; the annealing pot of Thomas Morgan in 1829; the tin pot rolls about 1865; and pickling machines, brushing and dusting machines, etc., at various times since. There are indications at the present time of important improvements in methods, especially in the rolling of the black plate that will very much cheapen its cost.

European Tin and Terne Plate Industry.

The manufacture of tin plates is carried on by 80 works and about 480 tin mills in Great Britain, and 40 works and 100 mills on the Continent of Europe. Of these Germany comes first with 10 works; Austria-Hungary has 9; France, 8; Prussia, 8; Spain, 1; Holland, 1; Poland, 2; Italy, 1.

A Brief Description of Tin Plate Making.

A brief description of the process of making tin plate is here given. The details of the process will be discussed more fully in other chapters. This brief statement gives the best practice at the Welsh tin mills.

TIN BAR ROLLING.

A steel or iron ingot or billet is first rolled into what is known as a "tin bar," which is a small billet usually seven inches wide and of the proper thickness for the orders in hand. This is sheared into lengths determined by the width of plates to be rolled, and taken to the sheet mill. It is here carefully heated to a good red heat in a specially constructed furnace, so as to avoid "scaling" of the bar. When sufficiently heated it is rolled or roughed down in "roughing" rolls. Two bars are roughed down at the same time which, when sufficiently reduced in thickness, are rolled, together, still further. They are then doubled upon themselves, reheated in another furnace similar to the first, and rolled down to the proper gauge or thickness in a pair of "finishing" rolls.

BLACK PICKLING.

The sheets when cool are sheared to size and passed on to the "pickling" room where they are subjected to the action of a strong mixture of sulphuric acid and water, heated by steam in leaden troughs. Here the plates are cleared of the scale formed during heating and rolling. They are then rinsed free of the acid, etc., in changes of water. This is called the black pickling process.

This "black pickling" is usually done by hand by means of tongs, but pickling machines are coming into general use. These effect a considerable saving in labor and acid. The spent or waste acid of the black pickling process is used for the second or "white pickling."

FIRST ANNEALING.

After pickling, &c., the plates are ready for the first "annealing." For this purpose they are carefully packed in cast iron or steel "pans" with a flange all around, and are covered with wrought iron or steel covers. The space between the cover and the flange is filled with sand to exclude the air. The packed "pans" and annealing "pots" are then run into an annealing furnace. Here they are kept for about 10 hours at a dull red heat until the heat has thoroughly soaked into the packs. After being taken out, the whole is allowed to cool before being unpacked.

COLD ROLLING AND ANNEALING.

The plates are next taken to the "cold rolling" department. They are passed through without heating at least 3 pairs of exceedingly hard chilled rolls, under very heavy pressure, the last pair being kept especially smooth and polished to give the plates a smooth surface. They are then reannealed in the same manner as for the first annealing and are passed on to the "tinning department."

WHITE PICKLING.

To finally prepare the plates for tinning they are again treated in a bath of acid and water, rinsed and scoured with sand and stored in clean water until they are wanted for tinning. This is termed "white pickling."

TINNING.

The plates are taken wet to the "tinning stacks," dipped in "grease," and put one at a time into the molten tin in the "tin pot," the tin being kept well covered with grease. After remaining in the molten tin sufficiently long to become properly coated with tin the "bath" of plates is lifted into the "washpot," also containing molten tin, after which the plates are brushed on both sides and passed singly through grease and rolls in the "machine pot." After leaving the machine pot the plates are put in a rack to set and cool.

DUSTING AND BOXING.

To clean the grease off the plates they are dipped either by hand or by machine into two separate lots of bran or sharps; and the dust is then wiped off by hand with sheepskin dusters, or by passing the plates through a machine fitted with rollers covered with felt and sheepskins. The process of manufacture being now complete the plates are carefully examined and sorted by an experienced workman. Those showing defects are put aside as *wasters;* the good are passed on as *primes*. Finally they are put into suitable boxes (the better quality having a sheet of tissue paper put between each plate), securely nailed up, branded and shipped.

Workpeople Employed.

The number of workpeople employed varies somewhat at different tin mills and works. In tables of cost given elsewhere the numbers at certain works are stated. A valued English correspondent gives the number as follows:

In each mill, 1 roller, 2 furnace men and 1 catcher, usually constitute a set for each "turn" or "shift," with 1 shearer per mill, assisted by a boy.

The "black pickling" when done by hand is done by men assisted by girls to do the swilling, that is the rinsing of the plates, 1 man and 2 girls being sufficient for 2 or 3 mills. Where pickling machines are used this amount of labor would be considerably reduced, as about 1 man and a boy would attend to a machine which would do the work for 3 or 4 mills. 1 man and assistant, with occasional assistance when charging, are capable of annealing the work of 2 or 3 mills.

"Cold rolling" is usually done by boys who are superintended by the cold roller; 1 boy will attend to 1 pair of rolls.

The pickling in the tinning department is also done by men assisted by girls to do the swilling, &c., 1 man pickling and 2 or 3 girls doing the work for 3 or 4 "stacks".

One tin man, 1 wash man, 1 drawer, at the stack, with 2 girls "dipping" and 1 girl dusting make up a set for each tinning stack, while 1 man "sorting" and 1 man boxing up, etc., with 1 boy assisting, would deal with work from 3 or 4 stacks.

In addition to the above there would be the engineer and fireman on each turn, also stocktakers and 1 or 2 laborers per mill.

Wages Earned.

Here again there is quite a discrepency. The same English correspondent whom we have before quoted gives the average wages earned per week, as follows.

Average Weekly Earnings in Welsh Tin Works.

Mill:		
Rollers, about	£3 10s.	per week.
Furnacemen, about	£3 0s.	do.
Catchers, about	£1 10s.	do.
Sheares, about	£3 0s.	do.
Tinning:		
Tin men, about	£2 10s. to £3	per week.
Wash man, about	£2 10s. to £3	per week.
Girls, about	12s. to 15s.	per week.

A correspondent from Wales makes the following statement as to the earnings at a certain works of the classes of labor named for a period of 26 weeks and the average per week:

Earnings at a Welsh Tin Plate Works.

Class of Labor.	Per week. £	s.	d.	For 26 weeks £	s.	d.
Rollers	2	10	11	66	3	10
Doublers	2	1	0	53	6	0
Furnace men	1	18	6	50	1	0
Behinders	0	18	7	24	3	2
Shearers	2	8	5	62	18	10
Tin men	2	4	9	58	3	6
Wash men	2	4	9	58	3	6
Risers	0	14	11	19	7	10
Assorters	2	4	9	58	3	6

It will be noted that these rates are much below those given by the English correspondent.

Wages Cost of Tin Plate.

From the same English correspondent whom we have quoted several times we have the following statement of approximate wages cost:

Mills.—The mill work which covers the roller, the 2 furnacemen and the catcher would cost in labor 10d. per box. The shearer and his assistant would cost 2d. per box with slight extras for special work such as cutting, splitting, etc. The forehands find their own underhands.

Black Pickling.—In this department too the forehand finds his own underhands. The cost of labor here is 1d. to 1¼d. per box.

Annealing.—Wage cost, 2d. per box.

Cold Rolling.—Wage cost, 1d. to 1¼d. per box.

While Pickling.—Wage cost, 1½d. per box.

Tinning.—Wages here are: Tin man 3d. per box; wash man, 3d.; drawer, 1d.; girls for dipping, 6s. each per 100 boxes. The dusting hand (girl) 4s. per 100 boxes.

Sorting.—Wages 2d. per box.

Boxing up and odd work. Day work wages about 3-6d. per day.

From our Welsh correspondent we have the following as the wages cost of working of 16½ boxes of tin plate, this being the amount which he claims 1 ton of tin bars will produce:

Rolling 16½ boxes, 4s. 6d.; doubling ditto, 3s. 8d.; furnacing ditto, 3s. 1d.; behinding, 1s. 8d.; shearing and binding, 1s. 8d.; opening, 1s.; cold-rolling, 1s.; annealing, 1s. 6d.; pickling, 1s. 8d.; tinning, 4s.; washing, 4s.; rising, 1s. 2d.; rubbing and dusting, 1s. 10d.; assorting, boxing and cover drying, 2s. 6d. Whole wages cost of 16½ boxes, 33s. 3d.

Other statements of labor or wages cost will be given under the head of Cost of Production of Tin Plates.

Cost of Production of Tin Plates.

Quoting again from our English correspondent, we have the following as the approximate cost of making 14x20 I C Bessemer tin plates, based on Bessemer tin bars at £5 per

ton delivered, fine foreign tin £92 per ton, and palm oil at £24:

Cost of Making a Box of 20x14 Bessemer Tin Plates.

Bars	5s.	6 d.
Tin, 2¾ lb.	2	3
Palm oil	0	3
Sharps	0	0.2
Acid	0	3
Coal	0	5.5
Management and wages	2	9
Stores, brasses, oils and grease	0	2.3
Castings and annealing pots and pans	0	2.2
Elm box	0	4.6
Rents, rates and taxes	0	0.7
Discounts, 5 per cent	0	8
Sundry charges	0	4.5
Cost per box	13	4

In the first column of the following table is the estimate of our Welsh correspondent of the cost of 16½ boxes of tin plate, which he regards as the product of one ton of tin bars. The second is the equivalent in American money, at 24c. to the shilling. The third column is the estimate of an American mill man of wide experience as to costs in the United States. We do not adopt the American figures, but give them for what they are worth. $26 to $28 per ton for tin plate bars would be a closer figure now, and $4 to $4.25 a better cost:

Comparative Estimate of Cost of 16½ Boxes I C 14x20 Tin Plate in Wales and the United States.

Materials, Labor and Cost.	Welsh Cost, English Money. £ s. d.	Equivalent in American Money.	Estimated Cost in the United States.
1 ton steel, 7x⅝ bars...	5 2 6	$24.60	$35.84
Less 486 lb. shearings...	9 0	2.16	2.34
Available at	4 13 6	$22.44	$33.50
Rolling	4 6	1.08	4.85
Behinding (catching)...	1 3	.30	.....
Doubling	3 8	.88	2.47
Furnacing (heating)	3 1	.74	2.10
Shearing	1 8	.40	2.43
Opening	1 0	.24	.76
Cold rolling	1 0	.24	.82
Annealing	1 6	.36	.82
Pickling	1 8	.40	1.65
Tinning	4 0	.96	1.98
Washing	4 0	.96	1.82
Rising	1 2	.28	.68
Rubbing and dusting...	1 0	.44	1.23
Assorting boxes, etc....	2 6	.60	1.65
2½ lb. tin per box, or 41¼ lb. per 16½ boxes	1 14 4½	8.25	8.71
Allowances for scruff...	1 0	.24	.27
Coal	6 6	1.56	1.80
Acid	6 0	1.44	1.84
Palm oil	6 6	1.56	1.32
Wood boxes	6 1½	1.45	1.55
Bran and middlings ...	2 6	.60	.60
Auncaling boxes (wear and tear)	1 4	.32	.82
Castings, etc. in the different depts. (wear and tear	3 0	.72	2.00
Management and clerks	2 0	.48	1.50
Other labor and trade expenses	6 0	1.44	4.50
Rates, taxes and bank charges	3 2	.76	1.25
Cost of 16½ boxes....	10 4 9	$49.14	$80.92
Cost of one box	12 6	2.97	4.90

In Consular Reports of the United States No. 78 we find the following very complete statement of cost of 100 boxes 14x20:

Cost of Tin and Terne Plate Manufacture in South Wales.

(This table is based on 100 boxes, as per brand mark, 14x20.)

Articles. Weight of bars, 14x20:	Tons.	Weight. Cwt.	Qrs.	Lb.
Iron	5	17	2	12
Steel	5	17	2	12
Waste reducing bars to sheets by oxidization and pickling		4	0	0
Waste by scrap		17	0	0
Yield of tin, 100 boxes bright....		2	2	20
" " " and lead each, 100 boxes ternes		1	1	10
Coal and coke	7	10	0	0
Vitriol, black and white pickling..		7	0	16
Palm oil		1	0	2

Bran, 1d. per box; boxes (wood), 4d. each; annealing pots, ½d. per box; machinery, wear and tear, rent and taxes, management, &c., and office help, 2d. per box.

The weight per box is as follows:

	Cwts.	Qrs.	Lb.
IC	1	0	0
IX	1	1	0
IXX	1	1	21
IXXX	1	2	14
IXXXX	1	3	7
IXXXXX	2	0	0
IXXXXXX	2	0	21

The extra cost in working IX is the cost of bars used in excess of IC. For instance, IX requires one-quarter of a hundred-weight more than IC. Up to IXX workmen's wages are the same as IC; after IXX the wages are doubled.

Wages Paid in the Manufacture of Tin Plates in Mills and Tin House.

Occupations.	Wages per 100. £	s.	d.
MILLS.			
Roller, 3s. 5d. per dozen	1	8	6
Doubler, 2s. 9d. per dozen	1	2	11
Furnaceman, 2s. 7d. per dozen	1	1	6
Behinder, 1s. 3d. per dozen		10	5
Shearer, 1s. 1d. per dozen		9	0
Opening		7	0
Engineman (by the day)		4	0
Pickler, black and white, swilling, &c		8	3
Annealing		6	4
Cold rolling		8	4
Bundlers		3	2½
TIN HOUSE.			
(Pickling white, dusting and scouring included in black pickling.)			
Tinning, 3d. per box	1	5	0
Washing, 3d. per box	1	5	0
Grease-boy, 1d. per box		8	4
Rubbing		6	6
Dusting		5	6
Assorting		7	2
Reckoning and weighing		0	9½
Boxiug		4	0
Laborers		4	9½
Engineer (see above)			
Overman		4	0
Horse and cart		2	8
MILLWRIGHT.			
Millwright and smith		2	8
Furnace-builder		2	0
Weigher		1	4
Smith (see above)			
Roll turner		4	0

Consul Jones, who makes the report, says: "The same wages are paid in all, or nearly all, the works in this district, as the workmen belong to the union, or Tin Plate Workmen's Association. There is some difference in the first hands, such as roll turner and tin house overman. I have not been able to get the exact sum paid at any one particular works throughout, but these are the ruling prices in all the works in my district. The explanation of one works paying and the other not paying is to be found in the management and construction of the works, and also in the brands, &c. The cost of wages per box amounts, at the present day, to 2s. 4d., very nearly."

Cost of Manufacturing 1500 Boxes I. C., 14 by 20 (One Week's Make of Three Mills).

Materials and expenses.	Weights. T.	Cwt.	Lb.	Cost per ton. £.	s.	Amount. £.	s.	d.	Cost per box. s.	d.
Steel bars	88	4	13	4	10	396	18	6	5	3½
Coal	112	10	0	...	5	28	2	6	...	4½
Castings	...	...	...	...	...	9	7	6	...	1½
Sulphuric acid	5	7	16	3	5	17	8	2	...	2¾
Tin	2	0	20	104	0	208	18	7	2	9½
Stoves and gas	...	...	...	...	...	12	10	0	...	2
Palm oil	0	16	8	28	0	22	10	0	...	3½
Rent, rates and taxes	...	...	...	...	...	3	15	0	...	0¾
Annealing pots	...	...	...	...	...	3	2	6	...	0½
Wooden boxes	...	...	...	...	...	25	0	0	...	4
Trade expenses and management	...	..	...	...	...	7	16	3	...	1¼
Wages	...	...	...	..	...	174	19	5	2	4
	...	...	...	...	...	910	8	5	12	1¾
Less shearing	13	0	0	2	0	26	0	0	...	4¼
	...	...	...	...	...	884	8	5	11	9½
Add carriage to Liverpool, 12s. 6d. per ton										7½
Add free-on-board charges at Liverpool										0¾
Net cost, delivered free on board, Liverpool									12	5¾

Tin plates are usually sold less 4 or 5 per cent for cash in 14 days.

The following statement, which is most complete, is from a Welsh works making 2000 boxes a week, having 4 mills turning out 500 boxes each. English money has been converted into United States currency at $4.85 to the £.

Number of Employes and Wages paid in the Manufacture of Tin Plate in Wales:

Girls.	Boys.	Men.		Per week.	Total.	Grand total.
...	...	2	Cutting iron and delivered to foreman	$ 4.36	$ 8.72	
...	...	12	Roller men	10.09	121.08	
...	...	12	Doublers	8.29	99.48	
...	...	12	Heaters	7.11	85.32	
...	12	...	Catchers	5.02	0.24	
...	...	4	Shearers and helpers	15.07	62.28	
12	...	.....	Openers	1.70	20.40	
...	6	.....	Boys bundling shearings	1.70	10.20	$467.72
			First Packing or Black Pickling.			
...	...	1	Pickler in charge	7.17	7.17	
...	3	.....	Boys filling cradle	2.18	6.54	
7	...	.....	Girls swilling and scouring	2.18	15.26	28.96
			First Annealing or Block Annealing.			
...	...	1	Annealer in charge	9.70	9.70	
...	....	4	Helpers	5.09	20.36	30.06
			Cold Rolling.			
...	.	1	Man in charge	5.82	5.82	
...	4	.....	Boys rolling	2.18	8.72	
...	4	.....	Boys catching	1.94	7.76	
...	2	.....	Boys greasing	1.94	3.88	
...	....	1	Man wheeling plates and weighing	4.61	4.61	30.79
			Second Annealing.			
...	...	1	Aunealer in charge;	7.17	7.17	
...	...	3	Helper	5.09	15.27	22.44
			Second Pickling.			
...	...	1	Pickler in charge	7.17	7.17	
...	3	.....	Boys filling cradle	2.18	654	
7	....	.....	Girls swilling and scouring plates	2.18	15.26	28.97
			Tinning and Washing.			
...	...	12	Tinners	10.09	121.08	
...	...	12	Washmen	10.09	121.08	
...	12	.....	Grease boys	3.36	40.32	
36	....	.....	Girls brauning and dusting..	1.81	65.16	
...	....	1	Man wheeling plates and coal	4.36	4.36	
...	...	1	Man lighting fires by night..	4.36	4.36	356.36
			Sorting Room.			
...	....	3	Sorters	8.72	26.16	
2	....	.....	Girls reckoning plates	2.18	4.36	
...	....	2	Men boxing plates	4.85	9.70	40.22
			General Charges.			
...	....	1	Roll turner in charge mills and cold rolls	14.55	14.55	
...	....	1	Tin house foreman charge pickling and annealing....	12.12	12.12	
...	....	2	Engineers in charge of mill engines	7.17	14.34	
...	..	2	Firemen	4.85	9.70	
...	....	1	Blacksmith	7.17	7.17	
...	....	1	Helper	4.36	4.36	
...	....	1	Bricklayer	7.17	7.17	
...	...	1	Helper	4.36	4.36	
...	1	.....	Driver small engine	3.59	3.59	
...	...	1	Millwright in charge of machinery	12.12	12.12	
...	...	1	Carpenter	5.82	5.82	
...	...	5	Laborers, all departments...	4.36	21.80	117.10
			Office Department.			
...	...	1	Superintendent	24.25	24.25	
...	...	1	Bookkeeper	9.70	9.70	
...	...	1	General clerk	6.06	6.06	
...		1	Timekeeper	4.85	4.85	44.86
64	47	107				1167.49

The following is the cost of making I. C. Bessemer plates, 14x20.

Cost of Making I. C. Tin Plates in Wales.

Steel bars at works, 136 pounds (at £4 15s. gross ton	$1 39
Block tin, 3 pounds per box	.62
Sulphuric acid	.10
Flux for tinning	.01
Coal for steam and heating through works	.16
Castings for general repairs	.04
Lamps, oil and lighting	.01
Clay, brick eye	.02
Lumber for packing boxes	.06
Nails, hemp, skins, brushes, &c	.00½
Bran for cleaning plates	.01
Palm oil	.06
Materials	$2.52½
Labor	.58½
	$3.11

Credit.

By shearings, 28 pounds	.10	.18
By tin scruff and copperas	.08	
IC plates, 20 x 14, cost per box		$2.93

AVERAGE COST OF TIN PLATE.

From the above it will be seen that we have 4 statements of costs. While it was to be

expected that there would be differences in these estimates growing out of a difference in the conditions of the works and the prices paid for material it is remarkable how closely they agree, the extremes 13s. 4d. and 11s. 9.6d. being but 1s. 6.4d. apart. Of the 4 statements of cost, 3 are within a range of about 8d. of each other.

The 4 statements of cost are as follows:

Cost of 14x20 I. C. Tin Plate in Wales per Box.

English correspondent	13s. 4 d.
Welsh correspondent	12s. 6 d.
Consular report	11s. 9.6 d.
English statement	12s. $2\frac{1}{2}$d.

As we have seen several statements from different sources that have been practically the same as that of the Welsh correspondent, 12s. 6d., we think this may be assumed as a fair estimate of cost. It may be stated that the correspondent is a works manager in Wales.

Substance, Sizes and Weights of Tin Plates.

The typical box of tin plate as to marks, sizes and weights is a box of IC 14″x20″, 112 sheets to a box and weighing originally 112 pounds, or a pound a sheet, but weighing now nominally 108 pounds to a box.

The marks IC, IX, IXX, DC, etc., refer to the thickness of the plates, or "substance," as it is termed. The thickness or gauges for the various marks, or substance, are as follows:

Marks of Tin Plate and Thickness of the Same.

IC	is equal to	No. 30 wire gauge.
IX	"	No. 28 "
IXX	"	No. 27 "
IXXX	"	No. 26 "
IXXXX	"	No. 25 "
DC	"	No. 28 "
DX	"	No. 26 "
DXX	"	No. 24 "
DXXX	"	No. 23 "
DXXXX	"	No. 22 "

The number of sheets in a box and the nominal net weight per box of the various thicknesses and sizes are as follows:

Marks, Weights and Number of Sheets in a Box of the Various Sizes of Tin and Terne Plates.

TIN PLATES.

Mark.	Size.	Sheets in box.	Nominal net weight per box. Lb.
IC	10 x14	225	108
IX	10 x14	225	135
IXX	0 x14	22[illegible]	1[illegible]6
IXXX	10 x14	225	178
IXXXX	10 x14	225	198
IC	14 x20	112	108
IX	14 x20	112	135
IXX	14 x20	112	156
IXXX	14 x20	112	178
IXXXX	14 x20	112	198
IC	20 x28	112	216
IX	20 x28	112	270
IXX	[illegible]0 x28	112	320
IXXX	20 x28	112	360
IXXXX	2[illegible] x28	112	400
DC	$12\frac{1}{2}$x17	100	94
DX	$12\frac{1}{2}$x17	100	122
DXX	$12\frac{1}{2}$x17	100	143
DXXX	$12\frac{1}{2}$x17	1[illegible]0	164
DXXXX	$12\frac{1}{2}$x17	100	185
DC	17 x25	100	188
DX	17 x25	100	244
DXX	17 x25	100	286
DXXX	17 x25	100	328
DXXXX	17 x25	100	370
IC	11 x11	225	97
IX	11 x11	225	121
IXX	11 x11	225	139
IC	12 x12	225	112
IX	12 x12	225	140
IXX	12 x12	225	161
IC	13 x13	225	135
IX	13 x13	225	169
IXX	13 x13	225	194
IC	14 x14	225	156
IX	14 x14	225	196
IXX	14 x14	225	225
IC	15 x15	225	180
IX	15 x15	222	225
IXX	15 x15	225	259
IC	16 x16	225	204
IX	16 x16	225	256
IXX	16 x16	225	294
IC	17 x17	112	115
IX	17 x17	112	144
IXX	17 x17	112	166
IC	18 x18	112	130
IX	18 x18	112	162
IXX	18 x18	112	186
IC	19 x19	112	144
IX	19 x19	112	180
IXX	19 x19	112	207
IC	20 x20	112	160
IX	20 x20	112	200
IXX	20 x20	112	230
IC	21 x21	112	176
IX	21 x21	112	220
IXX	21 x21	112	253
IC	22 x22	112	194
IX	22 x22	112	242
IXX	22 x22	112	278
IC	24 x24	112	231
IX	24 x24	112	288
IXX	24 x24	112	331
IXXX	24 x24	112	374
IXXXX	24 x24	112	417
IC	10 x20	225	160
IX	10 x20	225	200
IXX	10 x20	225	230
IC	11 x22	225	194
IX	11 x22	225	242
IXX	11 x22	225	278
IC	12 x24	112	112
IX	12 x24	112	140
IXX	12 x24	112	161
IC	13 x26	112	135
IX	13 x26	112	169
IXX	13 x26	112	194
IC	14 x28	112	156
IX	14 x28	112	196
IXX	14 x28	112	225
IC	14 x31	112	174
IX	14 x31	112	217
IXX	14 x31	112	250
IC	14 x22	112	123
IX	14 x22	112	154
IC	15 x21	112	126
IX	15 x21	112	157
IXX	20 x72	46	$7\frac{1}{4}$
IXXXX	20 x72	37	$9\frac{1}{2}$
IXX	30 x72	30	$11\frac{3}{4}$
IXXX	30 x72	27	$12\frac{3}{4}$
IXXXX	30 x72	25	14
IXXX	36 x72	35	$15\frac{1}{4}$
IXXXX	36 x72	20	$17\frac{1}{2}$
IXXXX	36 x84	16	$19\frac{1}{2}$
IXXXX	40 x84	14	25
TERNE PLATES.			
IC	14 x20	112	108
IX	14 x20	112	135
IC	20 x28	112	216

TAGGERS TIN AND TAGGERS IRON.

Size.	Wire Gauge.	Sheets.		
10x14	No. 38	450	112	lb.
10x14	No. 36	360	112	"
10x14	No 34	300	112	"
14x20	No. 38	225	112	"
14x20	No. 36	180	112	"
14x20	No. 34	150	112	"
20x28	No. 30	112	224	"
20x36	No. 30	87	224	"
20x28	No. 32	112	180	"
20x36	No. 32	87	180	"
20x40	No. 32	78	180	"

Prices of Tin Plate in England.

There is nothing more difficult than to quote the market price of a commodity, especially one into the price of which quality enters to the extent it does into that of tin plate. No two authorieties agree. The quotations of one broker, with the same or equal facilities for reaching a quotation, will differ from that of another, one trade journal from another and the official statistics of declared prices for export from all others.

The highest and lowest prices for I. C. coke from 1877 to 1891, according to the London *Ironmonger*, are given under the head of "British Exports of Tin Plate for 15 years."

In the following table are given the lowest and highest prices of I. C. coke tin plates at Liverpool from 1866 to 1891:

Lowest and Highest prices of I. C. Tin Plates (per box) in the Liverpool Market from 1866 to 1891:

	Lowest.			Highest.				Lowest.			Highest.		
	£.	s.	d.	£.	s.	d.		£.	s.	d.	£.	s.	d.
1866	1	4	6	1	6	6	1879	0	14	6	1	3	0
1867	1	1	6	1	4	6	1880	0	14	6	1	10	0
1868	1	1	6	1	4	0	1881	0	14	6	0	17	9
1869	1	3	6	1	4	0	1882	0	15	0	0	18	0
1870	1	3	0	1	4	6	1883	0	15	6	0	16	3
1871	1	4	6	1	8	6	1884	0	14	0	0	15	6
1872	1	8	6	2	2	0	1885	0	12	6	0	15	0
1873	1	10	0	1	17	0	1886	0	12	3	0	14	0
1874	1	9	0	1	12	6	1887	0	12	9	0	15	0
1875	1	1	0	1	11	0	1888	0	13	3	0	15	6
1876	0	19	6	1	11	0	1889	0	12	9	0	15	9
1877	0	17	0	0	18	9	1890	0	13	6	0	18	0
1878	0	13	0	0	16	9	1891	0	12	6	0	17	6

Tin Plate Manufacture in the United States.

Though, as will appear from tables given elsewhere, the United States is the largest consumer of tin plates among the nations, using in the neighborhood of 60 per cent of all the plates produced in Great Britain, and possibly more than half of all the plates made in the world, it has not been a producer of tin plates, except spasmodically, until about the time of the passage of the McKinley Bill. As a possible exception to this statement it should be noted that for some time previous to March, 1890, small amounts of terne plate had been made, and for some years certain parties engaged in stamping sheet iron and tin plates, and in making "articles, wares and vessels" from the materials, had done some tinning, both before and after stamping, for their own works, but have produced no tin plate for the market. There is no record of the amounts so made.

STAMPING PLATES TINNED.

Prior to the passage of the McKinley Bill a great deal of so called tin plate, that is, steel sheets with a very thin coating of tin—the least possible amount that could be put on the sheets—was imported for stamping. This stamping destroyed, as it was intended it should, the tin surface of the plates and they had to be retinned. As the result of the increased duty on tin plates this practice has been discontinued. Black plates untinned are now purchased for stamping and the "articles, wares and vessels" made from this black plate are tinned after stamping. The McKinley Act takes cognizance of this practice and provides (Par. 143 Indexed Tariff.) "That the amount or weight of sheet iron or sheet steel manufactured in the United States and applied or wrought in the manufacture of articles or wares tinned or terne-plated in the United States, with weight allowance as sold to manufacturers or others shall be considered as tin or terne plates produced in the United States within the meaning of this Act." In preparing to ascertain the production of tin plate in the United States from the first of July, 1890, as the Tariff Act provides shall be done, the special agent of the Treasury Department who has been placed in charge of the collection of these statistics will include as tin or terne plate the sheet iron or sheet steel so tinned or terne-plated.

THE TARIFF ACT OF 1864.

It is evident from its provisions that the tariff act of 1864 contemplated the laying of a duty on tin plate that would lead to the establishment of the industry in this country. The provisions of this act on tin plates was as follows: "On tin plates, and iron galvanized, or coated with any metal by electric batteries, or otherwise, ten cents and a half per pound."

SECRETARY FESSENDEN'S COMMA DECISION.

This would seem clear, but Mr. Fessenden, Secretary of the Treasury at that time, who did not know tin plates from tin, decided that there had been an error in punctuation; that the comma after plates should be removed and placed after iron in order to give the true meaning of the paragraph; holding that the intent of the paragraph was that tin plates as well as iron must be galvanized or coated in order to bear a duty of $2\frac{1}{2}$c a lb.

And the industry was not established. It has been argued that those desiring to make tin plate should have appealed to Congress to change the law. They did so, but with what result those who have had any experience in endeavoring to correct an important tariff law can imagine.

WELLSVILLE, LEECHBURG AND DEMMLER WORKS.

Notwithstanding the failure to secure a ruling of the Treasury Department that tin plates should bear the duty of $2\frac{1}{2}$c per lb., the price of tin plates in 1872 was so high as to lead to a belief that they could be made in this country at a profit even with a 15 per

cent duty *ad valorem* and works were projected and construction begun. The first works were built at Wellsville, Ohio, and put in operation early in 1873. At the time the works were started the quotations of tin plate in New York were as follows:

	Per box.
Prime charcoal, 14x20, ... 112 sheets...	$ 14.75
Coke, best quality 14x20......	14.50
Coke, second quality, 14x20	13.00
Coke, ordinary quality, 14x20...............	12.00
Each additional X..................................	2.25

The plates turned out at Wellsville were excellent. Between 1873 and 1878 tin plate was made by Rogers & Burchfield at Leechburg, Pa. The editor of the AMERICAN MANUFACTURER frequently visited these works, saw the plate made, and has in his possession to-day some kitchen utensils made from the tin produced at Leechburg at that time. It is interesting to note that natural gas was used in its manufacture. Both the Wellsville and Leechburg works were closed down in 1875.

In the meantime works had been built at Demmler, Pa., near Pittsburgh, known as the United States Iron and Tin Plate Works. These were erected chiefly through the activity and energy of Messrs. Protzman & Cowan, the former proprietors of the IRON WORLD, which was afterwards consolidated with the AMERICAN MANUFACTURER. By the time these works got in operations plates had fallen in price $2 to $3 a box, but it was still hoped that the enterprise would prove a success. The prices dropped further, however, and in October, 1878, charcoal plates had fallen to $6.25 a box, a decline of $8.50 a box from January, 1873. Coke was quoted at $5.18 a box, a reduction of $9.32 a box. At these prices, with a 15 per cent *ad valorem* duty, and American wages 100 per cent more than English, the industry could not continue.

CAUSE OF DELAY IN BUILDING TIN MILLS.

It is but fair to the manufacturers of the United States to call attention to the fact that the passage of the McKinley bill, October 1, 1890, was followed by the election of a House of Representatives the following November which, it was believed, and no doubt properly so, was opposed to the duty on tin plates levied by that act. Without knowing whether this change in the House of Representatives indicated an entire change in the views of the people on this subject, and a consequent early repeal of the provisions of the bill, manufacturers hesitated to go to the expense involved in building thoroughly equipped modern tin plate mills and works, which were the only ones that could have any chance of competing with the Welsh mills, and they waited.

Whether justly or not, these manufacturers conceived that the election of Major McKinley as Governor of Ohio was an indication that the policy outlined in the McKinley bill would not be reversed by the people, and at once preparations were made to erect mills at a number of points in the United States.

MILLS MAKING TIN IN 1892.

Among the important mills that are actually making tin plate, or have extensive works under construction, are the St. Louis Stamping Company; United States Iron and Tin Plate Manufacturing Company, Pittsburgh; Apollo Iron and Steel Company, Pittsburgh; Wallace, Banfield & Co., Irondale, O.; Norton Bros., Chicago; Somerton Tin Plate Works, Brooklyn; American Tin Plate Company, Elwood, Ind.; Anderson Tin Plate Company, Anderson, Ind.; Marshall Bros., Philadelphia; N. and G. Taylor, Philadelphia, and many others whose names will be found in a list published elsewhere.

Tin plate, terne plate and black plate are all being made in this country, and in quantities. More black plate is made than either terne or tin, and more terne than tin, but all are being made. The year 1892 will show a large production, and 1893 still larger, unless some notable change in policy or in business takes place. Time must be given to design and construct tin plate works. They are not built in a day.

British Exports of Tin Plates for 15 Years.

The following table from *The Ironmonger* shows the exports of tin and terne plates in cwts. from 1877 to 1891 inclusive, and the highest and lowest price for I. C. cokes during each year:

Year.	France.	United States.	British North America.	Australia.	Other Countries.	Total cwt.	Lowest price.	Highest price.
							s. d.	s. d.
1877	104,440	2,13',860	181 200	87,060	559,960	3,064,520	12 6	20 6
1878	107,660	2,162,480	108,940	73 940	648,400	3,101,420	18 3	18 3
1879	108,980	3,115,900	117,300	48,500	566,300	3 56,980	15 0	25 9
1880	84,380	3,283 40	208,060	89,260	691,320	4,354,360	16 0	30 9
1881	111,440	3,594,880	234,940	165,780	741 920	4,848,160	16 0	17 6
1882	81 180	4,291,040	17 ,200	117,420	637,580	5,300,420	15 0	18 6
1883	70,160	4,335,720	250,9 0	10 ,900	702,500	5,468,640	15 0	16 6
1884	82,560	4,138,740	328 600	120,260	967,840	5,642,300	15 3	16 6
188	97,920	4,453,100	296,780	154,600	949,640	5,952,040	14 3	15 0
1886	84,420	5,173,620	249,720	80,600	965,980	6,574, 40	12 9	14 9
1887	101,720	5,369,940	360,240	123,780	1,116,620	7,068,300	12 6	15 9
1888	8 ,780	5,847,180	407,220	157,260	1,139,460	7,821,120	12 9	15 3
1889	5,080	6,730,262	311,960	132,060	1,197,900	8,607,300	12 1½	17 0
1890	109,540	6,285,280	316,520	123,580	858,580	8,343,120	12 4½	18 0
1891	117,720	6,746,360	382,360	202,900	915,460	8,022,460	12 6	18 6

Production, Consumption and Export of Tin Plate from Great Britain.

In the following table, compiled chiefly from the British Board of trade returns, the Mineral Statistics of the United Kingdom and the reports of the British Iron Trade Association are given, so far as they could be ascertained, the number of tin plate works and mills, the total production of tin plate in boxes, with the total exportation, home consumption and exports to the United States :

Production and Exports of Tin Plates in Great Britain from 1870 to 1891, Inclusive.

YEAR.	Number of Works.	Number of Mills.	Total production. (Boxes)	Total exportation. (Boxes.)	Home consumption of stock. (Boxes.)	Exports to the United States. (Boxes.)	Percentage of exports to the United States.	Percentage of exports to to the United States to total exports.
1870	57		3,459,782	1,742,122	1,717,660	1,312,980	38	75
1871	57		2,393,29					
872	61		2.977,851	2,083,451	894 4 0			
18 3	69		2 685.045	2,153,477	531,568	1,511,632	56	70
1874	68		2,529,563	2,143,468	386,095	1,585,994	62	74
1875	68		2,952,116	2,448 986	503,130	1,673,435	57	68
1876	68		2,815,393	2,400,038	415,355	1,609,515	57	67
18 7	75		4,049,750	2,819,098	1,230,652	1,943,444	48	69
878	75		4,058,000	2,837,776	1,220,224	1,931.128	48	68
1879	78	264	4,250,345	3,534,169	716,176	2,755,421	65	78
1880	106	394	6,000,000	4,089,160	1,910,840	2,959 380	49	72
188	103	396	6,650,000	4,444,823	2,205,177	3,134,4 2	47	71
1882	95	378	5,944,633	4,564,549	1,380,084	3,565,249	60	78
1883	96	386	6,115,200	4,815,009	1,300,191	3,755,707	61	78
1884				5,121 001		3 572,782		70
1885	96			5,230,536		3 776,877		72
1886	96			5,841,937		4,393,071		75
188	83	391	7,433,528	6,207,388	1,226,140	4,526,367	61	73
1888	87	3.3		6,953 128		5,070,499		73
1889				7,401,529		5,559,734		75
1890			9,680,815	7 180,815	2,500,000	5 074,887		71

The statements of exports are from the Board of Trade returns, and are reliable. The figures of total production and home consumption are estimates, but are approximately correct.

Prices of Tin Plate in New York.

In the following tables is given the average price per box for I C coke tin plates in the New York market for each month of 1891, as well as the average price for each year from 1881 to 1891:

Average Price of I C Coke Tin Plate per Box in New York for 1891 by Months.

January	$5.40	July.	$5.35
February	5.45	August	5.35
March	5.35	September	5.45
April	5.25	October	5.35
May	5.20	November	5.30
June	5.35	December	5.30

Average Price per Box of I C coke Tin Plate in New York, 1881 to 1891.

1881	$5.05	1887	$4.40
1882	5.20	1888	4.45
1883	5.05	1889	4.35
1884	4.60	1890	4.75
1885	4.4	1891	5.35
1886	4.35	For the 11 years	4.75

It will be noted that the average price for 1891 was the highest for the eleven years by 60c. a box above the price for 1890, and the same amount above the average price for the eleven years, the average price being the same as the price for 1890. It appears, therefore, that notwithstanding the advance in duty of some $1.25 a box, and the great advance in price in 1891 owing to the demand before the McKinley bill went into effect, the advance in price in 1891 was only 60c. a box over the price for 1890 and the average price for the eleven years.

Production and Consumption of British Tin Plate in 1890.

Great Britain consumes but a small proportion of its own make of tin plates, less than one-fourth, while the United States consumes more than a half, nearly 60 per cent. The following table from *The Statist*, a well known English publication, shows the total production of tin plates in Great Britain in 1890, which it states to be a nornal year, the exports and home consumption. The figures of production and export are in cwts. of 112 lb.:

Exports and Home Consumption of British Made Tin Plates and Sheets, 1890.

	Cwts.	Per cent of total consumption.	Per cent of total exports.
United States	6,362,160	58.5	76.0
Russia	454,7 0	4.2	5.4
British N. America	322,540	3.0	3.8
Australasia	122,340	1.1	1.5
France	110, 20	1.0	1.3
Germany	109,560	1.0	1.3
Holland	82 280	0.8	1.0
Other countries	810,180	7.4	9.7
Total exports	8,374,500	77.0	100.0
Estimated home consumption	2,500,000	23.0	
Total consumption	10,874 500	100.0	

Imports of Tin Plate into the United States, 1867 to 1891.

In discussing the imports of tin plates into the United States two sets of figures, which of a necessity differ somewhat, will be used, one statement, based on the Board of Trade returns of the United Kingdom, the other the

statement of the Bureau of Statistics of the United States Treasury Department. The British Board of Trade returns are for the calendar year, those of our Bureau of Statistics are usually given for the fiscal year ending June 30. Through the courtesy of the Chief of the Bureau the accompanying table, showing the imports for calendar years has been specially prepared for us. As the British figures are of exports for a given year, while those of the United States are of imports, most of which come from Great Britain, there will be a difference in the figures for a given year.

In the following table is given the exports of tin and terne plates from Great Britain to the United States from 1867 to 1891 by calendar years as shown by the British Trade reports and the imports into the United States for the same period as shown by the statement of the Bureau of Statistics of the United States Treasury Department.

Exports of Tin and Terne Plate from Great Britain to the United States 1867 to 1891 and Imports of Tin and Terne Plate into the United States for the same period.

Year.	Imports into the U. S. cwts.	Exports from Great Britain. cwts.	Year.	Imports into the U. S. cwts.	Exports from Great Britain. cwts.
1867	1,577,426	1 060,224	1880	3,160,976	3,283 340
1868	1,258,725	1,250,909	1881	3,660,106	3,594 880
1869	1,591,346	1,472,445	1882	4,279,738	4,291,040
1870	1,419,354	1,507,453	1883	4,424,670	4,335,720
1871	1 659,377	1,738,580	18·4	4,323,618	4,138,740
187·	1,712,573	1,747,200	188	4,571,929	4,453,100
1873	1,605,798	1,710,620	1886	5,156,439	5,173,620
1874	1,595,551	1,828,140	1887	5,676 721	5,369,940
1875	1,821,110	1,919,900	1888	5,964,734	5,847,180
1876	1,798,942	1 804.640	1889	6,626,211	6,7·0,262
1877	2,249,584	2,131,860	1890	6.588,706	6,283,280
1878	2,155,889	2,162 480	1891	6,557,368	6,502,900
1879	3,085,014	3,115,900			

In addition to the tin plates that come to this country direct from Great Britain, some come indirectly via Canada, Mexico, etc.

The Tariff on Tin Plate and Its Provisions.

The tin plate clause of the McKinley act or the tariff law of October 1, 1890, is as follows:

(1.) All iron or steel sheets or plates, and all hoop, band or scroll iron or steel, excepting what are known commercially as tin plates, terne plates and taggers tin, and hereinafter provided for, when galvanized or coated with zinc or spelter or other metals, or any alloy of these metals, shall pay three-fourths of one cent per pound more duty than the rates imposed by the preceding paragraph upon the corresponding gauges or forms of common or black sheet or taggers iron or steel; (2) and on and after July first, eighteen hundred and ninety-one, all iron or steel sheets or plates, or taggers iron coated with tin or lead, or with a mixture of which these metals or either of them is a component part, by the dipping or any other process, and commercially known as tin plates, terne plates and taggers tin, shall pay two and two-tenths cents per pound; (3) *Provided*, That on and after July first, eighteen hundred and ninety-one, manufactures of which tin, tin plates, terne plates, taggers tin or either of them are component materials of chief value, and all articles, vessels or wares, manufactured, stamped or drawn from sheet iron or steel, such materials being the component of chief value, and coated wholly or in part with tin or lead or a mixture of which these metals or either of them is a component part, shall pay a duty of fifty-five per centum ad valorem: (4) *Provided further*, That on and after October first, eighteen hundred and ninety-seven, tin plates and terne plates lighter in weight than sixty-three pounds per hundred square feet shall be admitted free of duty, unless it shall be made to appear to the satisfaction of the President (who shall thereupon by proclamation make known the fact) that the aggregate quantity of such plates lighter than sixty-three pounds per hundred square feet produced in the United States during either of the six years next preceding June thirtieth, eighteen hundred and ninety-seven, has equaled one-third the amount of such plates imported and entered for consumption during any fiscal year after the passage of this act, and prior to said October first, eighteen hundred and ninety-seven: (5) *Provided*, That the amount of such plates manufactured into articles exported, and upon which a drawback shall be paid, shall not be included in ascertaining the amount of such importatons: (6) *And provided further*, That the amount or weight of sheet iron or sheet steel manufactured in the United States and applied or wrought in the manufacture of articles or wares tinned or terne-plated in the United States, with weight allowance as sold to manufacturers or others, shall be considered as tin and terne plates produced in the United States within the meaning of this act.

There are several points to be noted in relation to this clause that are often overlooked or misquoted and misunderstood.

The rate of duty is plain. It is 2 2-10c per lb. on all tin plate, terne plate and taggers tin of whatever gauge or weight of sheet without any reference to the amount of tin used in coating and including all tin coated or tin and lead coated sheets.

MISUNDERSTANDING REGARDING TARIFF PROVISIONS.

The misunderstanding is in regard to the provisions of the clause. To aid in discussing them they are numbered.

In the first place it is to be noted, see proviso 6, that sheet iron and sheet steel that is made into articles or wares and then tinned is considered as tin and terne plate as the case may be. So that under the tariff act the production of tin and terne plate is not only that of sheets tinned or terne plated, and so sold, but all the black plate that has been sold by the mills and tinned or terne plated by the stamper or consumer. In discussing the production of tin and terne plate in the United States this fact should not be overlooked. Certain parties who are seeking to remove the duty never note this fact but only consider the bright tin or terne sold tinned or terne plated, as tin or terne plate. No one who reads the law can be deceived. There has been a large tonnage of black plates sold in 1891 to be stamped and tinned that will count in the total product of 1891 as tin plate.

CONDITIONS UNDER WHICH DUTY WILL BE REMOVED IN 1897.

Probably the most misunderstood portion of this law is the fourth proviso. This enacts that after October 1, 1897, tin and terne plate lighter than 63 lb. per 100 square feet, which is No. 27 Birmingham and 26 American gauge, shall be admitted free of duty unless the amount of such plates made in the United Stated in any one fiscal year between July 1st, 1891, and June 30th, 1897, shall equal one-third the amount of such plates imported less the amount re-exported during any one fiscal year of these six years.

In connection with the proviso it is to be noted,

First. It applies only to sheets lighter than 27 Birmingham wire gauge, and the duty if it is removed through failure to comply into this provision will not be removed from all tin plate, as is generally believed, but only from that lighter than No. 27.

Second. In making comparisons the highest production of the United States in any one year may be compared with the lowest importations, that is the production of either of the six years may be compared with the imports of any of the six years.

Third. In ascertaining the amounts of imports for comparison with production, re-exported, tin plate is to be deducted from imports, while black plate tinned after stamping or other manufactures is to be added to production.

Fourth. Amounts of tin plate imported and remaining in government warehouses is not the standard of imports, but they must be both imported and entered for consumption.

TIN PLATE,

Material, Processes, and Machinery.

Material for the Black Plate.

The material for the black plate is now almost entirely open hearth steel, either acid or basic, for the better grades and Bessemer for the inferior. Before the introduction of steel, refined iron or charcoal iron was used for the best grade of work making "charcoal plates" and puddled iron or "coke iron" making "coke" plates. Though there was a difference in quality in these two grades neither the coke iron nor the charcoal iron could be relied upon. The plates were not uniform. The iron was never free from imperfections, resulting in serious loss and annoyance. The body of steel blooms when properly made is as a rule free from these imperfections, and if the surface of the bars and of the sheets made from steel is kept perfectly clean in the several departments a perfect sheet may be delivered to the tin man.

The Steel Bloom Furnace.

Assuming that we have a well made small steel ingot or bloom from the open-hearth furnace or Bessemer converter, the first operation is to roll this into a "*tin bar*," as it is called, which is a small bar or billet of the proper size, to be still further rolled in the tin mill, that is the sheet mill, into the black plate.

The ordinary heating furnace is well adapted to heating these blooms or ingots but great care should be taken to get a good fresh uniform heat. Overheating and burning the blooms should here, as in all heating, be strictly avoided. It is a very common fault to have in the same charge some of the blooms badly overheated and burned, and some not heated enough. This careless practice makes it very difficult to roll the bars to the required thickness.

The Bar Rolls.

The rolls in which the blooms or ingots are rolled into tin bars should, according to Mr. Joseph Phillips, in his articles in the AMERICAN MANUFACTURER of February 5 and 12, 1892, to which we are indebted for much of the practical detail of this chapter, have 6 grooves, 5 grain and 1, the last, a chilled groove. A good supply of water should always be used to keep the bars and the rolls free from scale in rolling. The last chilled groove gives the bar a good, smooth finish. A long water bosh should be provided into which the bar should be plunged and left to cool as soon as it is rolled. The water takes off what little surface scale there might be on the bar and prevents a fresh scale by keeping it from the atmosphere. The water bosh should have a good supply of water, 2 inlets, 1 at each end and the overflow in the middle. The rolls should always be kept in good shape by dressing them up in the housings and taken to the lathe at the end of the year to have a general overhauling if required. The roller should be careful not to roll any foreign substance that might be sticking on the bloom.

At Demmler, Pa., which may be regarded, so far as relates to machinery, as a well equipped mill, the sheet bar mill has 20-inch rolls.

The Tin Bar.

The practice of the best works is to roll the tin bar 7 inches wide, ½ to ⅝ or ¾ inches thick and of a length to be cut into bars of

the proper length for the orders on hand. In cutting the bars as they come from the tin bar rolls into these lengths a certain allowance is made for waste varying with the size of the plate and its gauge. In making I. C. substance, 23 pounds a box is allowed; for I. X., a few pounds more.

This bar cutting is done very closely and with his bar the mill man must bring out the required weight of black plates. The practice as to allowance differs in the various mills and for the latest practice there are no published rules. There is a book called the "Tinman's Companion," by the late Mr. William Lewis, published in 1877, which is found on the desk of almost every tin plate maker in Wales. This book gives rules and tables for ascertaining the allowances that shall be made in bars for rolling the several sizes of plates. Nowadays, however, the work is done more sparingly than even in 1877. Then 32 pounds were allowed for waste; now not over 23 for I. C. Bars, or pieces, as they are also called, for rolling. I. C. 20x14, the standard size, weigh 19 lb. 9 oz.; for IX., 11 lb. 8 oz.; IXX., 13 lb. 8 oz.; IXXX., 15 lb. 4 oz.; IXXXX., 17 lb. 4 oz.; IXXXXX., 19 lb. 2 oz.; IXXXXXX., 21 lb. 8 oz. Of course more than 1 sheet is rolled from each of these pieces.

It is estimated that a ton of tin bars will yield 16 to 16½ boxes of tin plate.

The Tin Mill Furnace.

We have now a clean bar to start with, free in a very great measure from surface scale. The bars should be heated only to a cherry red. Should the pieces be overheated we shall have as a result a layer of surface scale, and if rolled in we shall have rough sheets. Bits of clay, cinder, brick, scale, etc., rolled either in the bar at the bar rolls or into the sheets or bars in the tin mill will make the very worst of wasters and the trouble is they will not be discovered until it reaches the assorting table coated with tin, and with all of the labor and expense of bringing it down through its many stages.

There are various types of tin mill furnaces. In Wales the bottom is about 8′x5′ and stands about 3′ from the mill floor. The object in heating should be to bring the flame well over to the door and at the same time to maintain a volume of flame in the body of the furnace. Some have a flue in each jamb so as to keep the flame well down in the furnace. Others prefer a reverberatory furnace, while others find that a hole leading into the stack behind the center of the door works quite as well. The furnace should be wide enough to take in 3 piles of 21″ wide and should be high enough to turn the iron up on its edge: 24″ to the springing of the arch or roof is not too high. There is a difficulty in maintaining a clear flame in the furnace with very low roofs. The grate should be nearly as long as the width of the furnace. The mill furnaces are fired with slack, not an expensive item. A large grate will maintain a heavy volume of flame. The body of the furnaces should be filled up with old brick bats, etc., and not with earth. The furnace always works hard when filled up with earth and carefully bricked on the top of it. The furnace bottom may be finished off with about 8″ of puddlers' cinder broken up into small lumps.

There are made at each heat in Wales about five boxes of black plates. In 24 hours 20 charges are drawn, or 100 boxes a day.

The Tin Plate Mill.

The tin mill on which the bars we have been describing are rolled into sheets is one of the most important, as well as the most expensive, parts of a tin plant. Much of the delay in the erection of tin mills in the United States is due to the time required to plan and properly construct the trains of rolls known as the tin mill, as well as to some doubt as to what is the best form. We illustrate both a Welsh mill and a plan of a mill drawn by a noted American engineer, as well as form of mills proposed for increasing output and improving its quality.

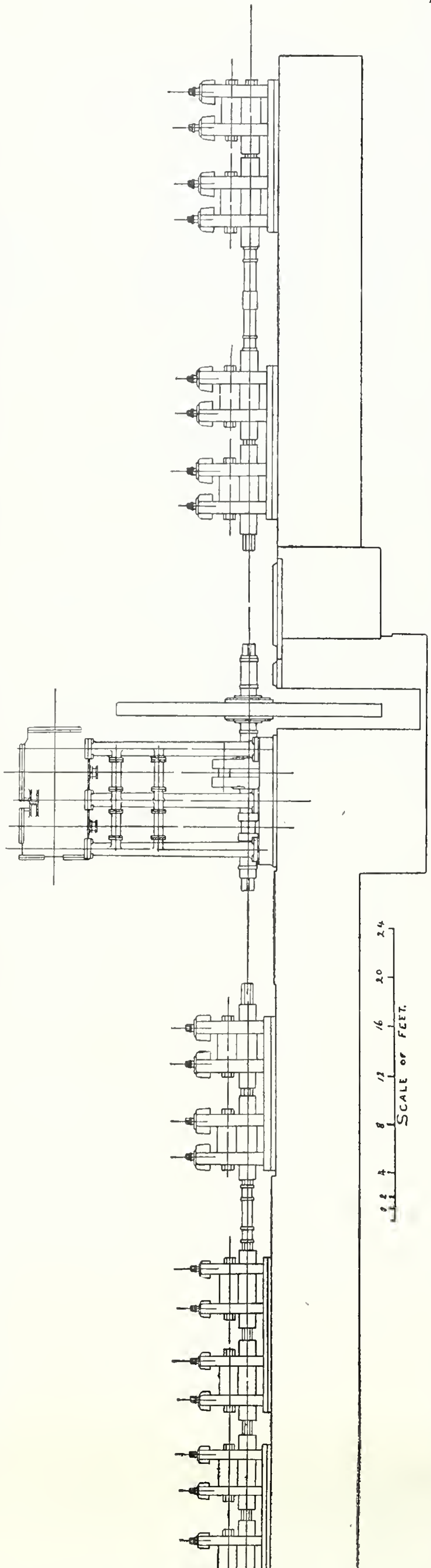


FIG. 14. An English Tin Plate Rolling Mill Plant. Elevation.

First some general considerations regarding the tin mill and the work it does. The tin bar is first passed through these rolls half a dozen times. When stretched to about 5 feet it is taken back to the furnace, then again brought to the rolls. It is then doubled and clipped at the doubling shear knife. A piece in IX is doubled thus twice; in IC, 3 or 4 times, as the case may be. At first the pieces are called "singles," then "doubles," then "fours," and then "eights," for the number of sheets is increasing by every doubling, and each sheet contained therein by every doubling becoming lighter.

Regarding the mill itself Mr. Phillips, before quoted, says:

"The mill standing should not be less than 21 feet from the center of the rolls to front of the furnace; when much shorter it makes it hot and crowded for the men to work and when much wider the men have not a natural swing in working. A prevailing mistake is to lay the floor too low. The roller and catcher should be well over and not under their work.

"The housing frame should not be less than 20″x14″, the top and bottom built in the same proportion with every angle rounded off well.

"The rolls should be about 30″ wide for rolling 20″x28″, and not less than 22″ in diameter, with a neck 14″ long, to suit the housing; diameter of neck, 18″. We have been a long time arriving at a black-plate roll neck this size. Parties may object to the body of a mill roll being 22″ or 24″ in diameter and a neck 18″ in diameter. A great many hold that the stretch will not be so good as with smaller bedy rolls. If the mill is kept in proper shape and the rolls turned properly there will not be the slightest difficulty experienced in that respect. The speed of the mill should be about 30 revolutions per minute. The slow motion rig for turning the rolls in the housing should be made strong enough, so that the turner will not work in fear of breaking it. There should always be enough of power to draw the mill and some to spare. There is great danger that parties may attempt to put down tin mills on a cheap scale because they are termed little mills. Tin, or rather black-plate, mills should have a surplus of power and great strength."

The tin mill at Demmler has 20″ rolls, 30″ wide run by a Corliss engine with cold rolls 18″ in diameter and 26″ wide.

OUTPUT OF A TIN PLATE MILL.

The output of a well equipped modern tin mill will average 500 to 600 boxes a week, according to the work in hand. An older mill, not so well designed or equipped, would make 450 to 500 boxes a week.

An English Tin Plate Rolling Plant.

The tin plate rolling plant of which we give illustrations (Figs. 14 and 15) is of the most recent type, manufactured by one of the leading rolling mill firms in England and is intended for a three mill set. It is the design of the Lilleshall Iron and Steel and Engineering Company, of Lilleshall, Shropshire. It is capable of rolling and finishing 40 boxes of mild steel heats per turn of 8 hours, making a total of 360 boxes in 24 hours for the three mills.

The fall of train over all is 120 feet. The height of rolls is 7 feet from the base and the height of engine 22 feet from the floor level. The size of plates mostly intended for this plant is 20x14 inches.

THE ENGINE.

The engine is a vertical, compound and condensing, with steam cylinders 26 inches and 24 inches in diameter and 46 in. piston stroke, placed on six massive iron columns, which rest upon a heavy bedplate. The high

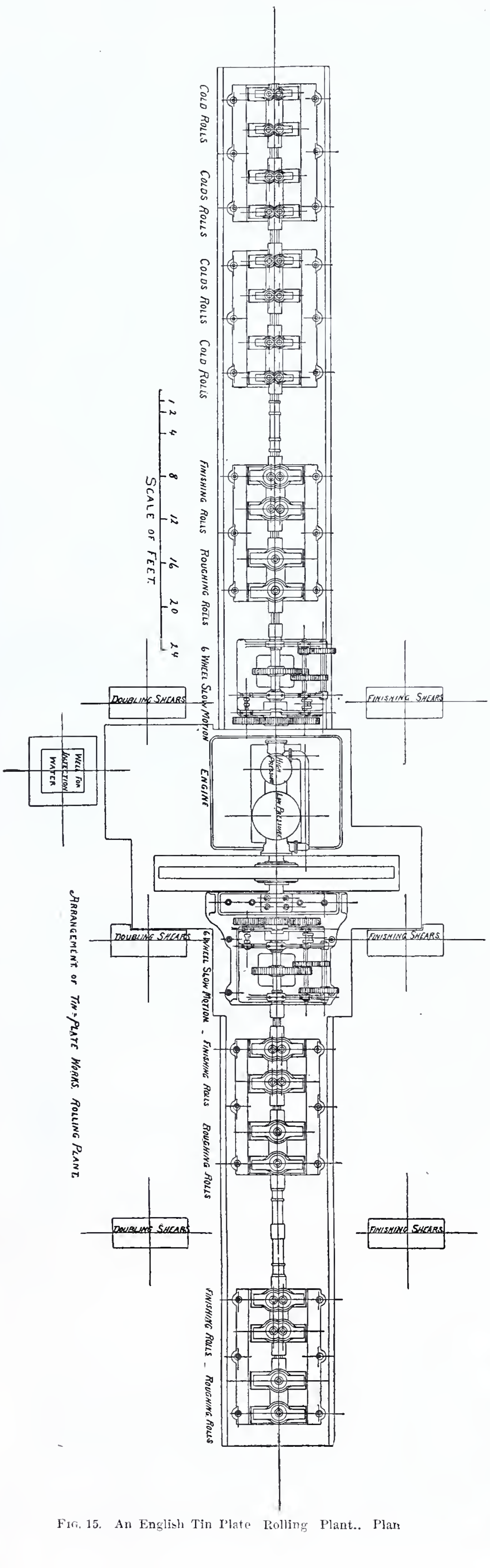


Fig. 15. An English Tin Plate Rolling Plant.. Plan

pressure cylinder is fitted with patent automatic cut off gear, controlled by high speed governor, and arranged to cut off steam varying from 60 per cent to 2 per cent of stroke. The crank shaft is of the build of modern marine type of enormous strength and carries a very heavy fly wheel.

COLD ROLLING MACHINERY.

The cold rolling machinery proper comprises all the necessary arrangements for full complement of 3 mills, 4 pairs of cold rolls, doubling and finishing shears and slow motions. Each mill consists of a pair of 19″ diameter, 26″ long, roughing mills and a pair of 19x26-inch finishing rolls. So far as regards the standards, necks, and so on, the roughing and the finishing rolls are exactly the same, and are indeed interchangeable, except that there are two screws in the standard of the finishing rolls by means of which the rolls can be adjusted to a greater nicety. The necks are 14 inches in diameter by 10 inches long, and the wobbles 11¾ inches in diameter and 7½ inches long. Nearly every roll maker in England has a special wobble of his own, but in the plant under description the plans have been set out with the view of making all the wobbles uniform. This is accomplished by the employment of a special method of dividing the circle, and without having to use templates or anything of that description. All sizes of wobbles can be made uniform. By means of a plate and screws on the end of the brass in the rider, the brass is set close up to the rolls so that all side play is entirely done away with.

The standards are fitted with phosphor bronze bearings, wrought iron riders, dished steel thrust block, wrought iron screws, with hardened steel points, working in wrought iron boxes. The standards are bored to receive the screw boxes, which are turned to fitand keyed in their places.

The cold rolls are similarly fitted but the standards are much lighter, and the riders of cast iron. The rolls are 18 inches in diameter by 2 feet 2 inches long, necks 12 inches in diameter by 10 inches, and wobbles 10 inches in diameter by 7 inches long. The chief difference between these rolls and the finishing rolls is that a cast iron "breaker" is included in the design which is put over the riderin order that if any extra strain comes upon the standards, instead of they themselves being liable to break, the damage ensues to the breaker, and a greatly lessened cost is entailed in repairs. These rolls are also fitted with two screws, and the boxes are turned to fit the standards.

ROLLS.

All the rolls are chilled about ⅝ inch deep. Sometimes a ¾-inch chill is applied but it is found in England that the chill must not exceed this depth or it becomes too great. The spindles carrying the rolls are of Siemens Martin steel, with necks 10 inches in diameter by 10 inches long. The mill roll spindles are 9 feet in length and the cold roll spindles 6 feet. The mill is intended to be worked at an average speed of 40 revolutions per minute.

THE SLOW MOTION.

The slow motions are a special feature of the plant and are entirely selfcontained. One large casting which forms the base has all the bearings cast on. The motion includes main spindle with cast steel clutch, and gearing to reduce the speed to about 1½ turns per minute when the engine is running full speed. The mill beds are planed for the standards, which are made of superior cast iron to rest on. The standards are also planed along the bottom. The beds are very heavy and long enough to take two pairs of rolls in each case. They are of the ordinary quality iron with dove-tail fillings. The shears are so arranged that the connecting rod is in tension during the shearing of the plate, and they are fitted with means of gauging and squaring the plates.

WEIGHT OF PLANT.

Exclusive of the engine, the total weight of the plant is about 212 tons made up as follows: Three mills (40 tons 11 cwt. each) 122 tons, 4 pairs of cold rolls, 52 tons; six doubling and finishing shears, 13 tons; 2 slow tions, 24 tons, and spindles and connections, 4 tons.

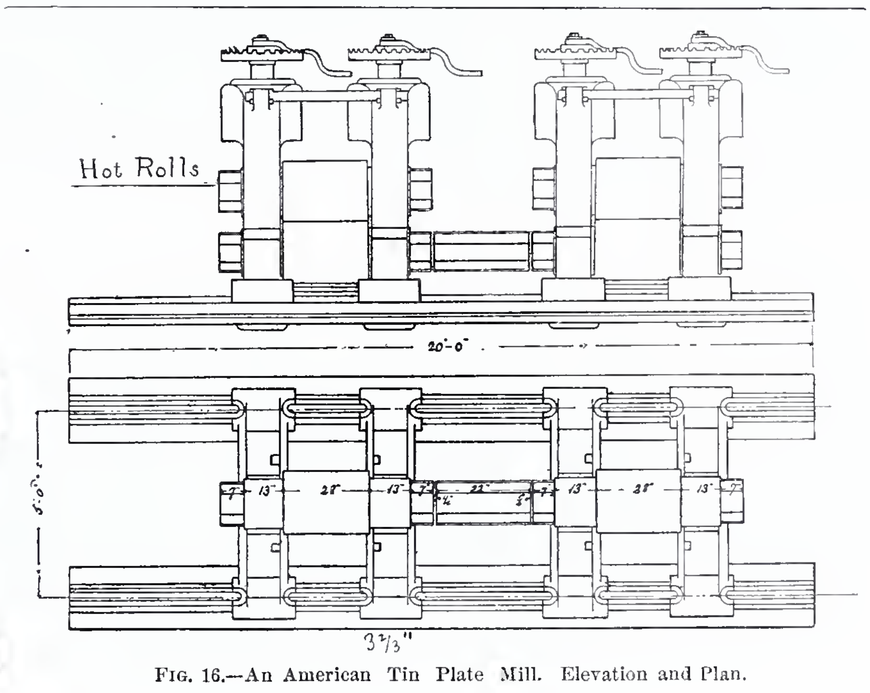


Fig. 16.—An American Tin Plate Mill. Elevation and Plan.

An American Tin Plate Mill.

In Figs. 16 and 17 is shown a design for a tin plate mill prepared by an eminent American rolling mill engineer. As the dimensions are plainly shown on the engraving no extended discription is necessary. Both the hot and cold rolls are 28 inches wide.

In placing these mills, as will be shown in a plan given elsewhere (Fig. 34) showing the arrangement of a tin plate works as suggested by this same engineer the cold rolls are not put on a line with the hot rolls as they are in the English tin plate mill (Figs. 14 and 15), but in the rear, the black pickling and annealing departments being so arranged that the black plate passes through them on its way to the cold rolls without traversing the same distance twice.

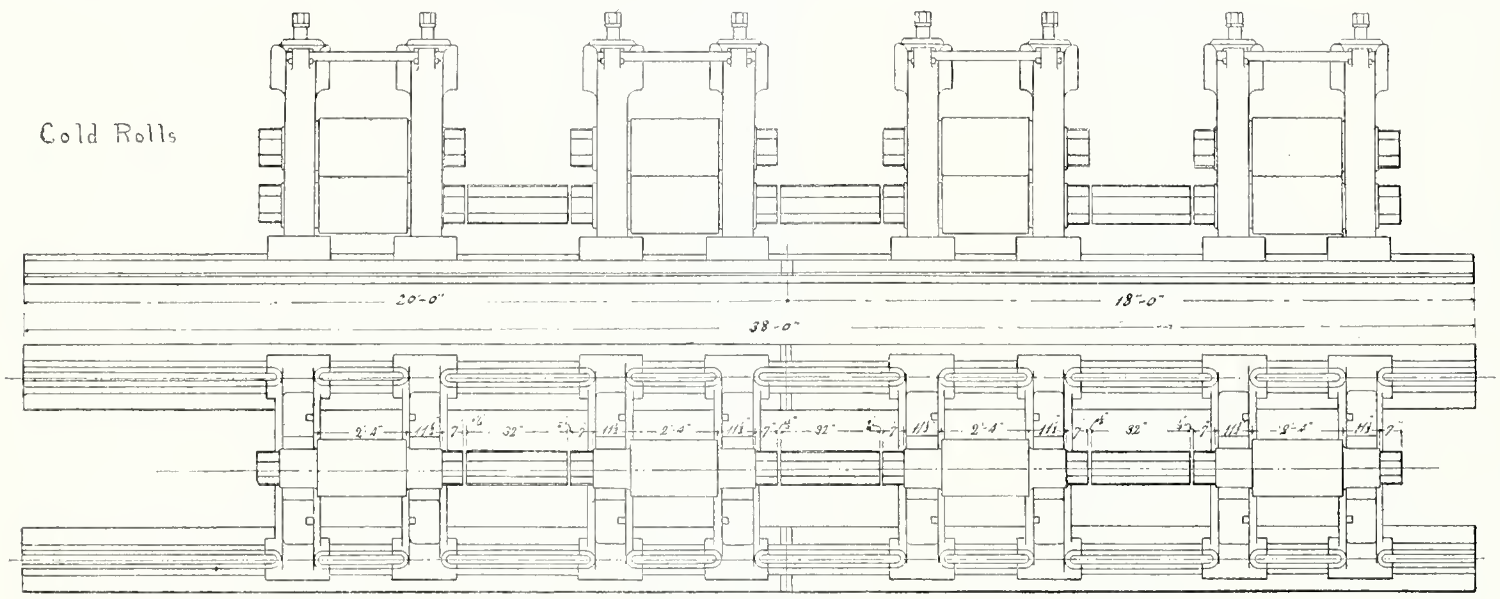


Fig. 17.—An American Tin Plate Mill. Elevation and Plan.

New Methods of Rolling Black Pl e

Quite a number of suggestions as to forms of mills for rolling tin plates more rapidly, or in some way other than in the ordinary tin mill have been suggested, but none have as yet been finally tested and adopted.

ROLLING SHEETS FROM FLUID METAL.

One of the most interesting of these mills is the one designed to roll sheets from fluid metal, which is being perfected by Norton Brothers, of Chicago. While this mill has not been perfected the development is proceeding satisfactorily, at least to the gentlemen who are making the experiments, and contains at least enough of promise to justify flattering words from so eminent an engineer as Mr. Robert W. Hunt, who referred to it in his recent address as President of the Society of Mechanical Engineers, administering at the same time a mild rebuke to Sir Henry Bessemer for his somewhat cavalier reference to what the Nortons had done in perfecting a method for rolling fluid metal into sheets.

SHEET BARS DIRECT FROM INGOTS.

It has also been suggested that a great saving would be made if the sheet bar was rolled at once from the ingot instead of first being bloomed down on the blooming mill and then rolled into a bar on the bar rolls. The theory is that there would be a great saving in labor and expense in having the bar delivered to the tin mill of the required width and 1/8″ thick rather than 7″ wide and 5/8″ or 3/4″ thick.

OTHER SUGGESTIONS.

It has also been suggested that the bars be rolled to the necessary gauge with a pair of rolls similar to nail plate rolls with grooves the proper width. Another method proposed is to run the sheet mill so as to get sheets wider and longer than those now usually made. A three-high mill with a guide back of the rolls to throw the plate between the upper pair without handling has been designed.

A CONTINUOUS TIN PLATE MILL.

A suggestion that is meeting with some favor is a continuous mill, in which the bars are rolled down to the required gauge to 30 w. g., and even thinner, by a series of rolls so arranged as to reduce the bar in one or two operations without doubling, reheating and rerolling.

We illustrate such a mill, the invention of Mr. W. C. Howell, of Philadelphia (Figs. 18 and 19). Fig. 18 is the blooming mill, Fig. 19 the sheet mill. In operation the slab or

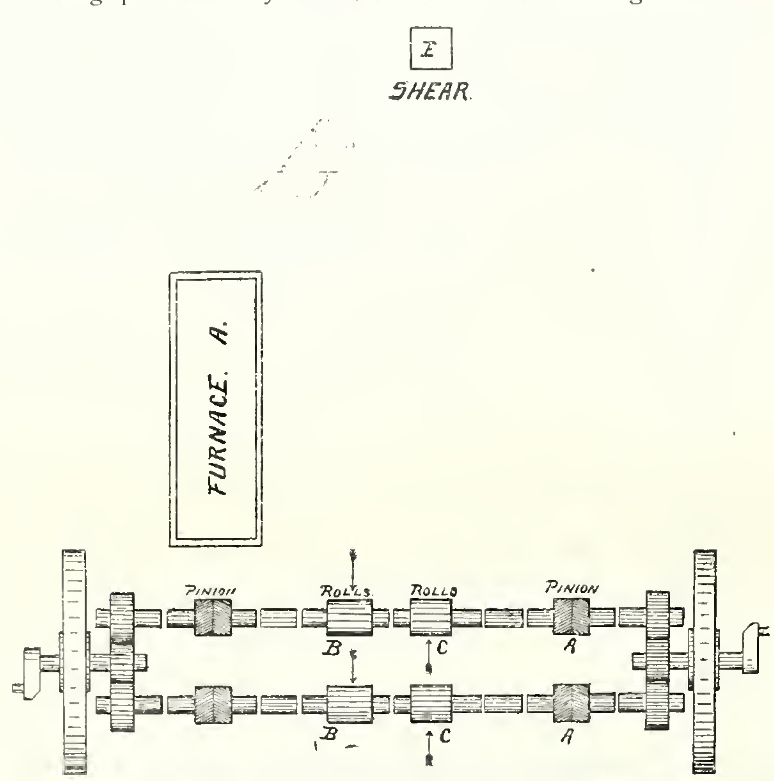


Fig. 18.—The Howell Continuous Sheet Rolling Mill.

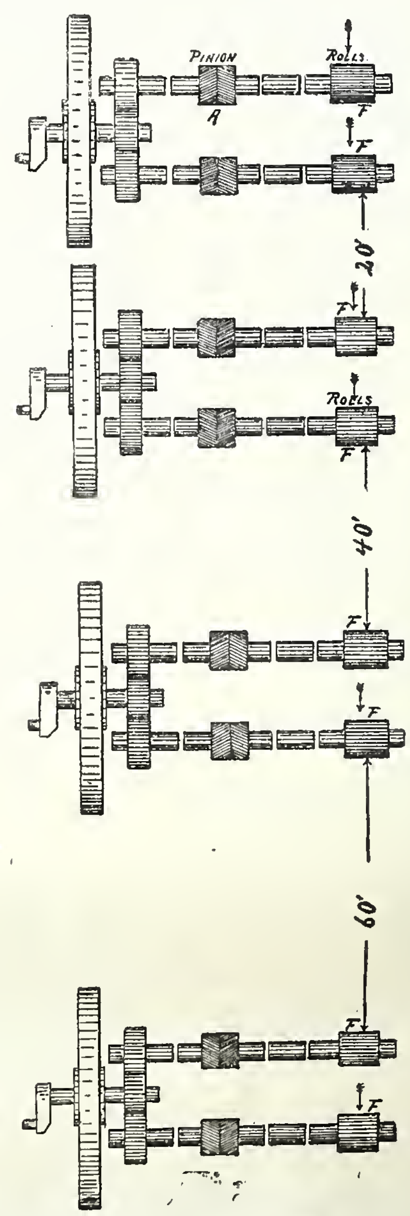


Fig. 19.—The Howell Continuous Sheet Rolli ng Mill.

ingot is taken from the heating furnace A, Fig. 18, and passed through the rolls BB in the direction indicated by the arrows receiving therein two reductions. It is then moved laterally to the rolls CC, again passed back to the rolls BB, and so on until it is reduced to ⅛ inch thick, when it is taken to the shears E, cut into shorter lengths and built into "packs" ½ inch in thickness, and, without reheating, sent to the continuous roll train, Fig. 19. It is next passed through the series of rolls F, when the operation of hot rolling is completed. The strips may be of any desired length, say from 60 to 100 feet.

The entire system of rolls is on one plane, no lifting of the work being necessary, only a short lateral movement in the blooming mill from the rolls BB to CC. The continuous train is built in detached independent sections for the better control of the speed of the different groups, the strip to leave one set of rolls about the time it enters the next, and thus avoiding many of the complications peculiar to continuous trains.

This mill is especially designed for the production of the sheets for tin plate.

The Leechburg Doubling Shear.

The accompanying cuts, Figs. 20 and 21, show the front and side elevation of an improved doubling shear manufactured by the Leechburg Foundry and Machine Company, Pittsburgh, which is meeting with great favor. Within the past 60 days 9 have been shipped to different tin plate works now being erected and this does not exhaust the orders on hand. This shear, including the vertical engine and connections, occupies a floor space of 4¼ by 8½ feet.

Among the advantages which this shear has is that the power and connections are all above the foundation; that it requires a less expensive foundation than the underground driven shears. This enables it to be placed in any position it is found most convenient in the mill. The fixed tables also are not found on other shears. The table extends from the back part of the doubling arm to within a foot of the point of the knife edges. The table rests on four ribs which are cast to the main body of the shear as shown on the end elevation, Fig. 20. These ribs in addition to supporting the table prevent the bottom knife holder from springing when the shear is cutting. The doubling arm is bolted to the back part of the shear lever which has slotted holes which enable the arm to be adjusted to come within any distance of the table. This arm has a stroke of 8 inches which will take in the double of any sheet very easily and with one stroke will perfectly flatten the double. Without a fixed table and rigid arm which is fit perfectly to the shear lever, many strokes are often required to perfectly flatten the double of a sheet.

The shear blades are 36 inches long made of the best tool steel and are reversible. The engine is also of the the most improved pattern and is geared to the shear 6 to 1, which gives ample power to cut any sized pack of sheets.

Black Pickling.

In the Welsh practice, when the black plates have been sheared behind the rolls (this location of the shears is not well thought of by some tin plate makers in the United States), where the pile of, say, 8 hours' or 12 hours' work has been allowed to cool, they are opened by girls, who receive about 6 shillings per 100 boxes. When open the plates, on a little trolley, are taken to the black or first pickling. This pickling, formerly done with a tongs by hand, is now done by pickling machines, of which several patents exist—Hutchings, Williams, Grey, Howells. The former is mostly in use, and to be found at the most modern constructed tin plate works in Great Britain and on the Continent. This Hutchings machine is much simpler in construction than the Grey and others, and works with a good yield.

The importance of proper pickling cannot be overestimated. Pickle blisters make bad wasters, and black spots (oxide) allowed to pass on into the annealing box will give trouble later on. It is very important that pickling should not be done in a haphazard way. If the sheets are not much damaged they are oftentimes imperfectly done. It is also asserted that pin holes in tin plates are the result of bad pickling and annealing. It is claimed that the pickler and annealer who take IC, IX and IXX and treat them all the same will find that the plates will give considerable trouble from pin holes. The heavier the plate the longer they should be pickled and annealed, and where a distinction is made in the treatment between the heavy plates and light plates there is no trouble from pin holes, except once in a while when some of the workmen are careless.

The Hutchings Pickling Machine.

The form of pickling machine shown in Figs. 22 and 23, the Hutchins, is the one most in use in British and European tin plate works. The cradles can be lifted either by hand or steam. The steam cylinder for this purpose is shown in the cut, while above the tee beam of the elevation of the machine is shown a sheave which may be used if the steam is low or wanting.

The operation of the machine will be readily understood from the drawings. It consists essentially of a triangular arm attached to the piston of a steam cylinder standing vertically. From these arms drop rods that carry at their lower ends the cradles or racks in which are placed the sheets to be pickled. When the arms are in the position represented in the cut, one of the cradles has just been loaded ready for pickling, while a second is in the pickling vat, and the third, after having passed through the pickling vat is in the swilling or rinsing vat. By the mechanism shown on the left side of the plan, Fig. 23, a backward and forward, and by other mechanism, even a rising or falling or jerking motion can be imparted to the plates both in the pickling and swilling vats. The cradles, it is needless to say, are transferred in succession from the loading rack to the pickling vat, and from this to the swilling vat, and thence to the loading rack, where they are unloaded.

These machines are made in 2 sizes, the largest capable of pickling 600 boxes of black plates a day, the smaller to handle the production of a works with 2 or 3 trains of rolls.

As to the advantage of this method of pickling over hand-pickling Messrs. Hughes, Chemery & Co., of London, who control the manufacture of these machines state:

"At present a pickler can finish, on an average, by ordinary hand work, 120 boxes of ordinary plates 20″x14″, or 180 of white plates per day, while with this machine the same pickler can finish 300 boxes of black plate and 300 boxes of white plate, a total of 600 boxes per man per day.

"By this process the sheets are pickled in so perfect and complete a manner and washed in so short a time that the surface given by cold rolling is not injured, and consequently the plate will be much better finished and its surface become much more brillliant and smooth after tinning than is possible, if it is treated by the usual hand method.

"As sawdust is not used in the process of cleaning, a considerable reduction in the number of wasters (second grade) is obtained, and also a great economy in the consumption of heat and in the wear and tear of pots in coating over again.

"In the tinning department a workman, on an average, with this process of pickling and washing can plate 30 boxes of sheets in less time than that usually required for tinning 25 boxes.

"Also the defective plates, which require retreatment because of their imperfect pickling and washing, and the adhesion of sawdust, amounting generally to four boxes a day, may be fully estimated at one box a week if this patent is employed. The economy is then plain and conclusive.

The following statement of the saving accomplished by the use of this machine, in comparison with the common hand method, has been taken from the results obtained in its operation in several establishments which have adopted it:

Cost of Labor.—The sum commonly paid for pickling, etc., according to the hand me

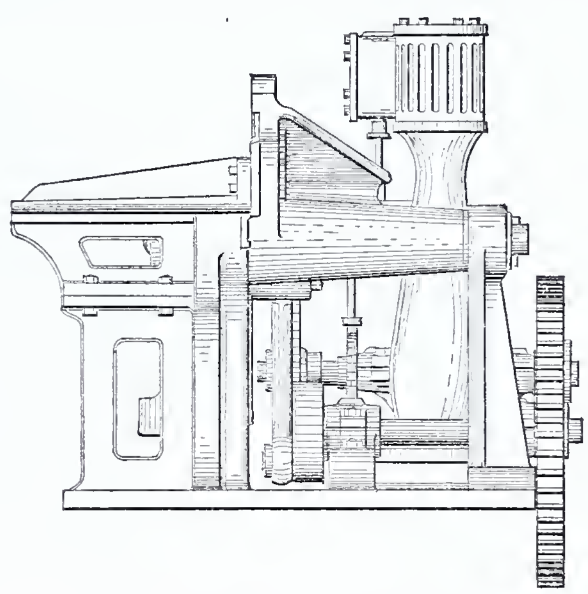


Fig. 20.—The Leechburg Doubling Shear. End Elevation.

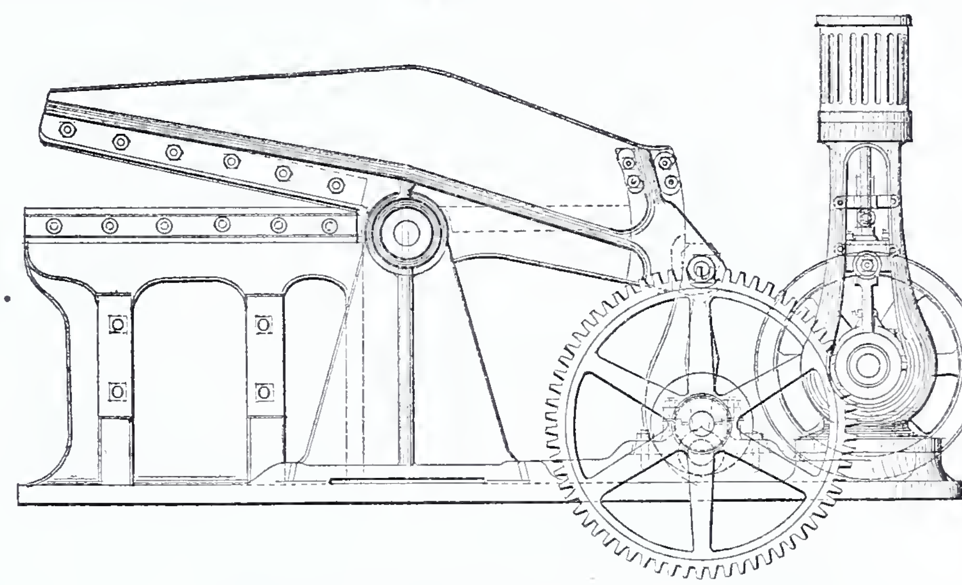


Fig. 21.—The Leechburg Doubling Shear. Side Elevation.

thod, is 24s. per 100 boxes, while the same average of work done with this machine costs 8s. per 100 boxes, hence an economy of 16s. per 100 boxes, - - - per box, 1 1-9d.

Acid.—The average economy attending the least favorable results is 2½ lb. of sulphuric acid per box, £6 7s. 6d. per ton, or 7-10 of a penny per lb., - - - per box, 1.9d.

Tin.—The saving of metal amounts to ½ lb. per box, sometimes more, sometimes less, but for this statement we take the most unfavorable, say, ¼ lb. at £95 per ton, or 10 3-20 pence per lb., - - per box, 2.5d.

Waster Plates, or Tin Plates of Second Quality.—There is a reduction of at least 5 per cent over the usual proportion of 1 C. W., say, at a difference of 2s. for coke (plus considerable for X), - - - per box, 1.2d.

The saving in the coal consumed in the process of recoating, together with the diminished wear of the pots and other utensils, necessary to recoat, is considerable, but we have not included them in the figures in this statement. - - - Total, 7.5d.

7½d. per box 1 C. 20x14, ordinary coke, is equal to a saving of £3250 per year for one works which produces 2000 boxes per week.

The Acme Pickling Machine.

Figs. 24 and 25 show a pickling machine which is now employed in Wales, Fig. 24 being a plan, and Fig. 25 an elevation.

The parts of the machine are as follows: A, yellow metal cradles; B, pickling tank; C, water tank; D, steam or hydraulic cylinder; E, triangular frame; F W I, levers for working cradles; G, gearing for working cradles; I, balance weight; J, suspenders; K, connecting rod.

The plates are put on edge in the cradles, the emptying and filling being done at A. When the cradle is filled it is transferred to the acid in pickling tank B, where it is moved to and fro in the pickle by means of the levers F and gearing G, driven by an engine or available power. When the plates are sufficiently cleared the cradle is transferred to water tank C and again rocked to and fro in the water until the acid is rinsed or washed from the plates. The cradle is then removed to A, plates taken out and fresh ones put in to be pickled and washed. As there are three cradles hung on the triangular frame E, the "pickling," "swilling" and changing of plates proceeds continuously.

The Mesta Automatic Pickling Machine.

The accompanying cuts, Figs. 26 and 27, show a vertical section, side elevation and plan of a pickling machine designed by George Mesta, of the Leechburg Foundry and Machine Company of Pittsburgh.

The machine consists of a 16″ vertical cylinder supported by a vertical base, and in the cylinder is operated a plunger which supports the cross arms from which are suspended the brass crates containing the plates which are to be pickled and washed. Three cross arms are here represented, though more could be used if deemed necessary to pass the plates through more than one washing vat. The plates while being pickled and washed receive a vertical motion which is transmitted to them by means of rods attached to the cross arms, which are moved by the plunger. This plunger can be given either a long or short stroke. The crates are immersed in the pickling and washing liquids, and then, by means of the short automatic stroke, are rapidly moved up and down and the liquid forced between the plates, accomplishing a thorough pickling and washing.

This automatic motion can be regulated at any degree of speed, or given any length of stroke.

When the process of pickling and washing is completed the crates can be raised out of and above the vats by disconnecting the pin from the vertical rod which is attached to the plunger, and thus giving the plunger its long stroke

The plunger may then be revolved thus bringing the crate containing the pickled plates over the washing vat and the one containing the washed plates into a position where it can be disconnected from the cross arm for the purpose of unloading and refilling. While this is being done the hand lever is thrown up thereby again giving the machine its automatic or short stroke, thereby repeating the pickling and washing process The Leechburg Foundry and Machine Company has just completed one of these machines for the new tin plate works in Ohio The machine was tested a few days ago a the shops and the test proved very satisfactory.

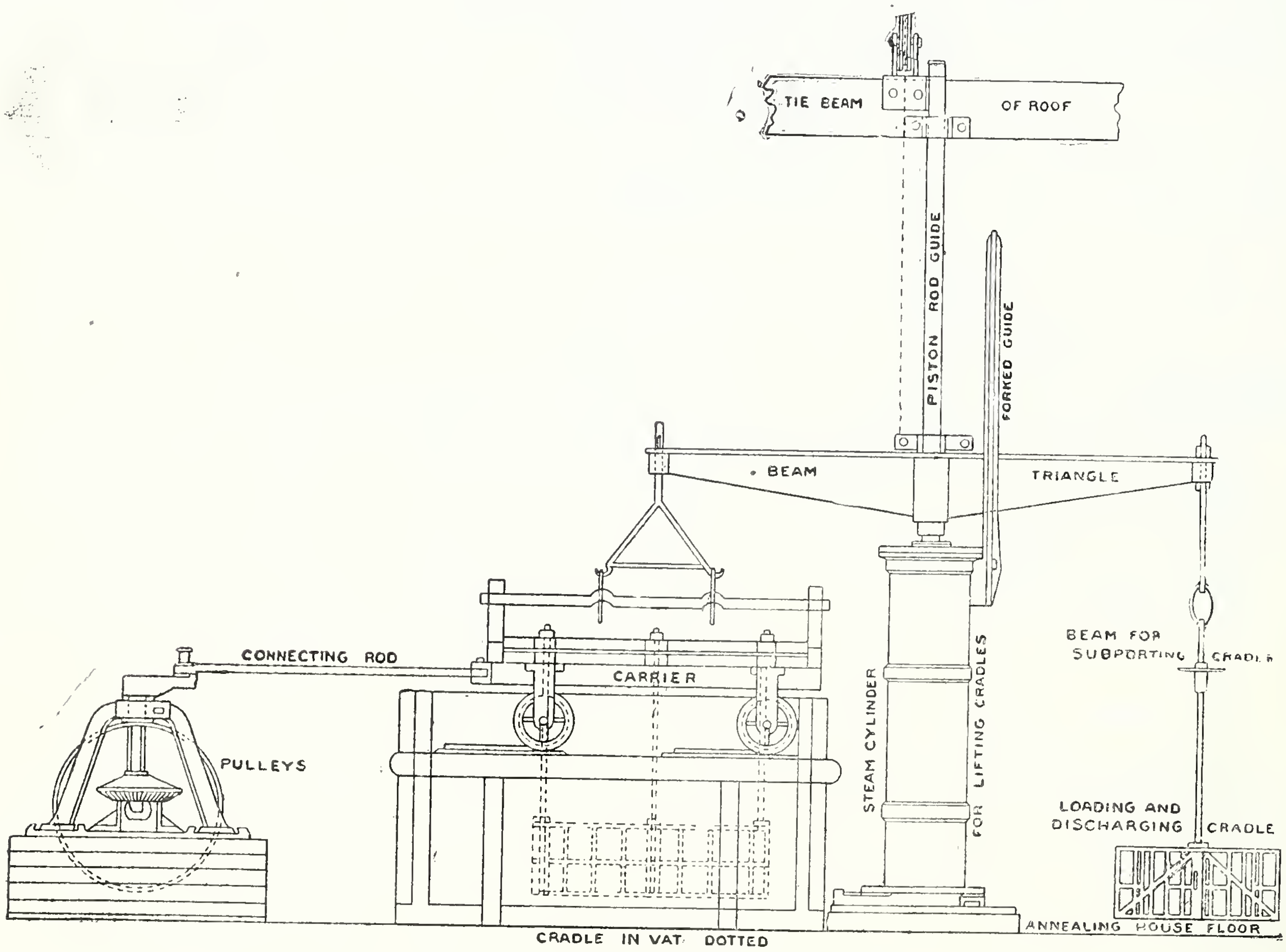


FIG. 22.—Hutchins Patent Horizontal Pickling Machine. Elevation

First Annealing.

From the pickling and water vats the plates are placed on cast iron stands covered with either cast iron or wrought iron covers and placed in the annealing furnace to anneal. The bottom of this furnace is on a level with the floor of the mill, the boxes being run in and out of the furnace by means of a long handled two wheeled carriage. The size of the furnace differs. Our Welsh correspondent recommends 14x11 feet. The time of an-

nealing differs with the furnace and gauge of plate. Eleven hours perhaps is a fair statement of the time required to anneal.

Regarding this process, and the furnace used, Mr. Phillips says: "Any idea of erecting the old-fashioned annealing furnace, with the flame rushing over the bridge into the furnace, should be abandoned. There are better constructed annealing furnaces in use now. A properly constructed furnace is very essential to secure good results. The idea is to distribute the flame into the furnace uniformly and to keep the box or boxes enveloped in a volume of flame. A furnace that will do so will anneal the iron better and destroy less boxes. It is a well-known fact that boxes and their contents are often damaged, and in some cases destroyed, by inexperienced hands, and very often by those who should know better, by unduly rushing the fires. Some parties now advocate large boxes such as are used for sheet iron. These certainly take considerably less space in the furnace and less outside space to anneal a given quantity of work, but should the big box crack, which it very often does without much warning, its contents of several tons would be badly damaged from air leakage. Moreover, the box itself is a very expensive item to be replaced. The little box will stand a harder rub in the heat without cracking or otherwise collapsing. The big box may become the box of the future."

Cold Rolling.

When the plates are removed from the annealing furnace they are allowed to cool before removing the covers. When cool they are cold rolled.

There is a great difference of opinion among practical mill men as to the proper position of the cold rolls relative to the hot rolls. In most old mills the cold rolls are attached to the tin plate mill, or hot rolls, and run by the same engine. In many modern mills, and especially in large works, they are placed by themselves and run by their own engine. Indeed, the tendency of all modern rolling mill practice is to give each train its own power.

Three pairs of rolls are usually placed alongside each other. These rolls are of the hardest quality, and each roll has more pressure than the other, and toward the finish, or last pair of rolls, the surface of the rolls is smoother and smoother.

The remarks of Mr. Phillips in the AMERICAN MANUFACTURER on cold rolling are worth reproducing. He says:

"I have always found it a convenience to have cold rolls the same size as the mill rolls, even if the neck is 18″ in diameter. The sheets as a general rule get from 3 to 4 passes, that is, according to the state of the rolls and the amount of pressure put upon them. The object is to get a smooth, glass-like surface, as free as possible from any kind of roll marks. The very closest attention should be paid at this stage of the operation. A badly cold rolled sheet will not make a good-looking tinned sheet. There have been the most ingenious machines designed and patented and in practical use for working up sheets to any desired form, but in consequence of the intense pressure required to close up the surface pores of the sheet and the delicate nature of the work nothing up to the present time has been substituted for a pair of chilled rolls to do the work. All that can be practically suggested is for parties to put down their cold rolls in the most convenient place to be found, disconnected, if possible, from mill trains. My experience has been that it has given far better satisfaction to work all kinds of machinery in a rolling mill as far as practicable disconnected."

Cold rolls are illustrated under the title of "The Tin Plate Mill," in a previous part of this Supplement.

Second Annealing.

After cold rolling the plates have lost their flexibility and are again annealed to take out the brittleness. This does not require so long a time as the first annealing, say 7 hours. It is done in the same kind of a furnace but should be done with great care.

The best boxes should always be used in the second annealing; care should be taken that the boxes are perfectly air-tight. The smooth surface of the sheets will cause them to stick if overheated. Give the boxes sufficient time for the heat to penetrate into the centre of the iron; let it be done with a volume of flame without forcing the fires. Cold rolled sheets over-annealed and made to stick to each other mean a destroyed surface.

Second Pickling.

When removed from the second annealing the boxes of plates are placed beside the white pickling vats. When cool the boxes are uncovered and receive a slight dipping in the pickling vat and are thoroughly washed and placed in the water trough for tinning.

The object of the second pickling is to again remove all impurities from the surface of the sheets and make them perfectly white and clean, ready for tinning. Great care should be used to have a good supply of water.

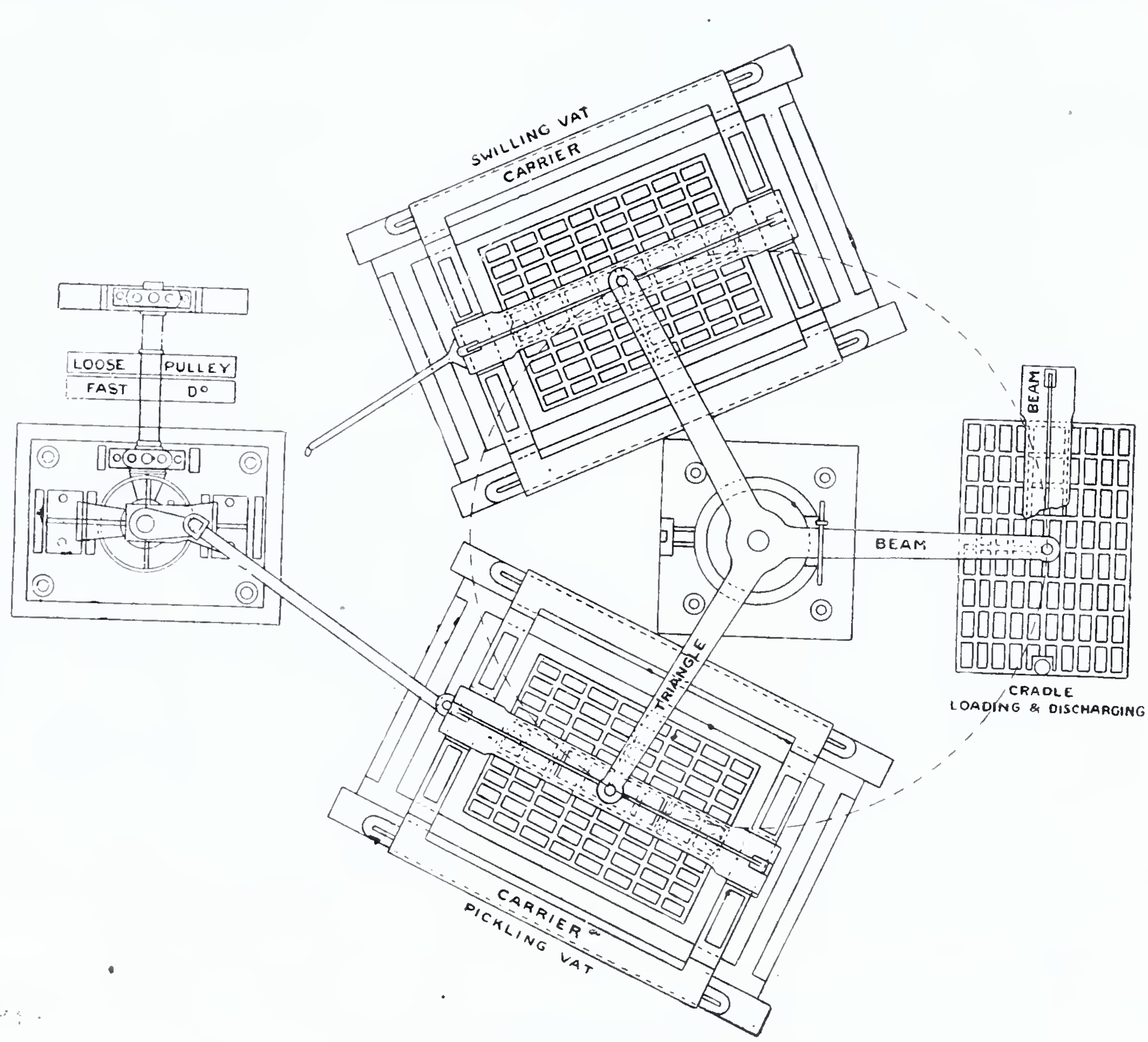


FIG. 23—Hutchins Horizontal Pickling Machine. Plan S.

Tinning.

The black plates are now supposed to be duly and properly made and cleaned of all scale and surface imperfections and ready for tinning.

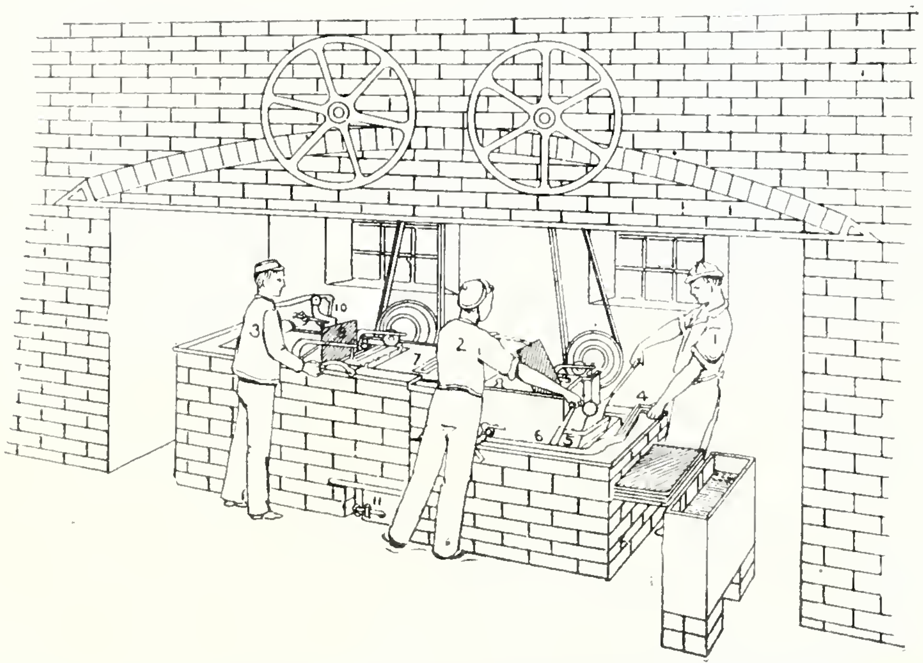


Fig. 28. Taylor Stove, Eaton & Price's Patent Tinning Apparatus for Charcoal Plates.

1, Tinman; 2, Dipper Boy; 3, Catcher Boy; 4, Clip for taking down and lifting Plates; 5, Tinning Hopper; 6, Weighted Lever for canting over Plates in the Pot; 7, Dipping Pot of Clear Metal; 8, Finishing Grease Pot; 9, Plate finished, coming out of the Rolls; 10, Hand Pump used for taking up Metal rolled off in Finishing; 11, Fire Door under Dipping Pot.

As to the necessity of a proper sheet, Mr. Phillips says:

It cannot be repeated too often that it is a very difficult thing to give the tinman a perfect sheet. He has to receive the perfect and imperfect all mixed up and the block tin coating that he puts on is not thick enough to cover up the defects. The good and bad sheets pass on through other hands with a coating of tin on it, after which the assorter gives them a final separation. The perfect sheets are thrown on one pile, the imperfect sheets are thrown on a pile called waste. This means a difference in the market price of between 50c and $1 per box, and sometimes it is difficult to sell them at any price. The annoying fact is that the same price is paid for the steel bar or bloom, the labor, and the block tin for imperfect as for perfect sheets. We shall never be free from wasters, but when the proportion of wasters runs above the legitimate line it becomes a serious loss, hence the wisdom of adopting the best known methods in every department to keep down the waste and the "waste waste" piles on the assorter's table.

"Let it be distinctly understood that a sheet that will pass for a perfect galvanized sheet would make an abominable "waste waste" sheet in a terne plate and a sheet that may pass for a perfect terne plate would make a bad waster in a tin plate. The coating of spelter in the galvanized sheet is thick enough to cover up the defects and the coating of tin and lead will cover up defects that block tin will not."

Labor-saving Methods in the Tin House.

Quite a number of labor-saving appliances have been introduced into the tin house, the chief being the double pot, the Morewood grease pot, the combined pots, and the cleaning machine. The one great feature about an improvement in labor-saving machines in the pickling or the tin house departments is that as a rule the quality of the sheet is not destroyed, it only puts those in charge to an inconvenience until they have either mastered or condemned it.

We illustrate a number of the labor-saving appliances.

Tinning Pots.

THE TAYLOR-STRUVE POT.

In the accompanying illustration, Fig. 28, is shown Taylor, Struve, Eaton and Price's patent tinning apparatus for charcoal plates. It is combined with the Morewood dipping and grease pot and is used for tinning and finishing the best quality plates, the equivalent of the old charcoal plates. It is adapted to tinning the lightest taggers and the heaviest cross and will finish with the thickness of coating desired. It has a capacity of 40 boxes a day.

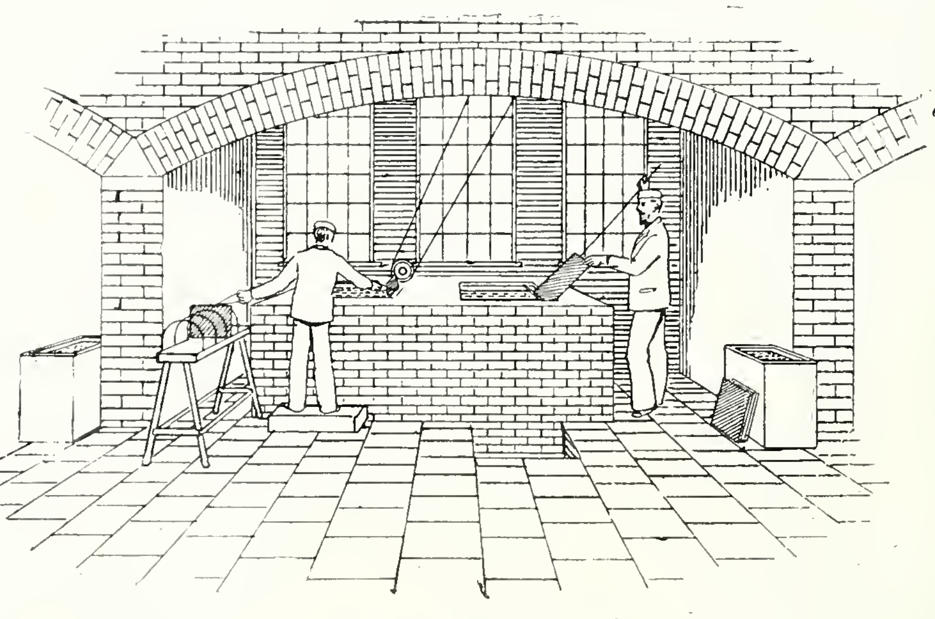


Fig. 32. Jenkins' Patent Tinning Machine.

The length of the combined apparatus is measured at the brick work at the bottom, 8 feet 6 inches, and the depth of the stack from the front to rear is 5 feet 6 inches.

This system consists of a single pot in which plates are first coated. To obtain a heavier coating of a sound, solid, bright character, a narrow dipping pot is used. This is placed close beside the single pot. The plate is then finished in an ordinary grease pot of the Morewood or any other construction. By this means any weight of tin from 3½ up to even 8 or 9 pounds per box can be coated. The three pots are all arranged close together so that the youth catching the plates carrying out of the single pots dips them into the dipping pot and the same youth puts them into the grease pot. The plates are not knocked about by frequent handlings, the sound coating given in the first pot is a splendid foundation, thereby very much reducing the chances of pinholes, which has always been a difficulty which makers of the finest qualities of charcoal plates have hitherto been unable to overcome.

No brushing is required whatever, and rich looking plate is produced, with a saving of at least 1 pound of metal per box.

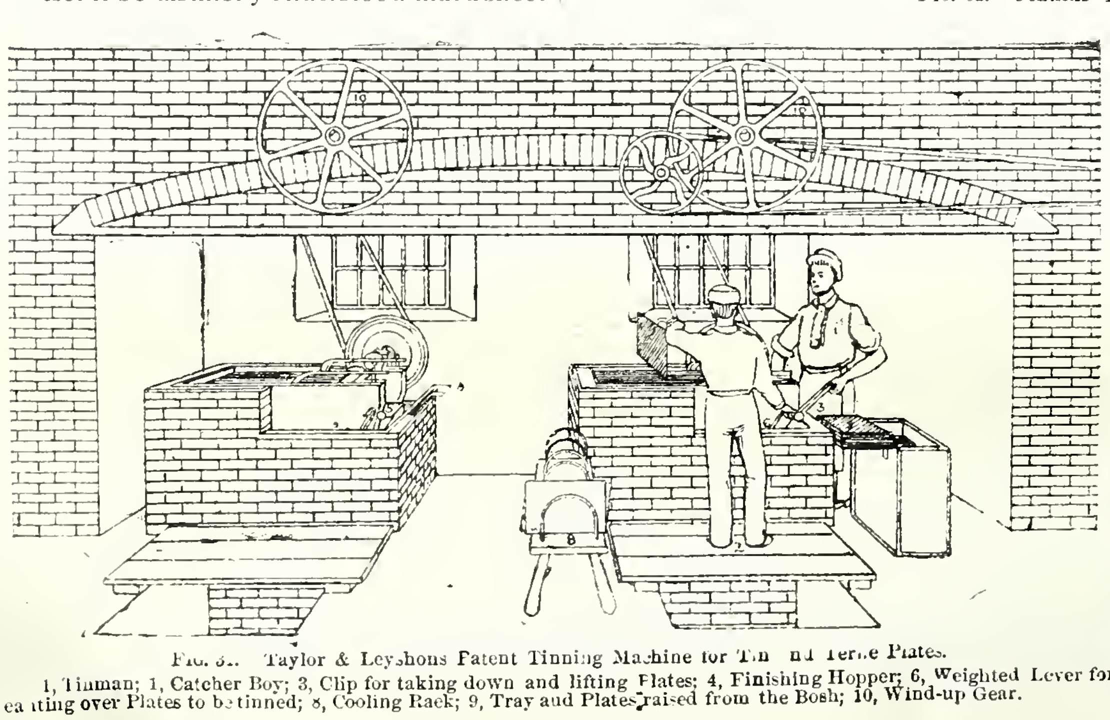


Fig. 3[illegible]. Taylor & Leyshons Patent Tinning Machine for Tin and Terne Plates.

1, Tinman; 1, Catcher Boy; 3, Clip for taking down and lifting Plates; 4, Finishing Hopper; 6, Weighted Lever for canting over Plates to be tinned; 8, Cooling Rack; 9, Tray and Plates raised from the Bosh; 10, Wind-up Gear.

DETAILS OF A TINNING POT.

Figs. 28 and 29 illustrate a 5-roller machine pot for "drawing" tin plates, to deal with sizes up to 28x20 inches, in which the plate is rolled in the direction of its length, but at some works the rolls are made long enough and the pot sufficiently wide to roll the plates sideways or in the direction of their width. This enables more work to be done through a machine, as they are used as "double" machines when working on 14x20 or smaller sizes.

AA. Frames carrying tinned rolls 1, 2, 3, 4 and 5.
C. Cradle suspended from shaft S, and capable of adjustment for length of plate by means of a long screw passing through nut IV.
F. Fingers or forks to push plate forward.
G. Guide bars.
H. Cross bar to carry guide plates not shown.
S. Shaft carrying fingers and cradle.
P. Spring for regulating pressure on rolls.

The rolls are geared together at one end by pinions and geared to driving shaft at the other. This shaft is drawn from a main line of shafting through any suitable arrangement of gearing and belting. The arrangement most in use for this purpose being a pair of "taper" or "step" cones to regulate the speed, driving a worm geared in a worm wheel on the driving shaft.

The pot is filled with grease at a working level slightly above the center line of top rolls, and kept at the temperature of molten tin. The rolls are carefully tinned all over their surface, and fed with molten tin from time to time as required. A pump is kept in the pot to pump out the excess of tin which accumulates in the bottom of the pot.

The plates from the wash pot, after being brushed, are passed down into the hot grease in the machine pot between the rolls 1 and 2 on to the cradle C, then by means of a handle on the end of shaft S. The fingers F push the plate forward against the guide bars G, and at the same time the cradle is lifted until the plate is caught by rolls 4 and 5, and rolled upwards out of the grease through rolls 2 and 3. It is then caught and put into a rack to set and cool. "Drawing" between rolls makes the plates more evenly coated with tin, and also produces a sounder plate than does the process of "drawing" by hand.

TINNING COKE PLATES.

Fig. 31 shows two 28″x20″ tinning machines for coke-finished plates placed in one ordinary 18-foot stack. This make of machine is at work in the chief tin plate works of South Wales and the continent of Europe. It differs from the Taylor-Struve pot, Fig. 28, in not having the Morewood 5-roll grease pot. This pot has a capacity of 40 boxes a day, and coats with 2½ to 3 pounds of tin per box.

THE JENKINS TIN POT.

The Jenkins tin pot, Fig. 32, is patented both in England and the United States. It needs no description, as its action will be evident from the illustration.

TINNING IN ONE OPERATION.

Many attempts have been made, with more or less success, to coat tin plates in a machine pot in one operation. This is effected by passing the plates singly through a suitable flux (such as chloride of zinc) into a bath of molten tin, and then out of this bath between rolls immersed in grease as before described. Rapid work is done in this way, but the plates are not looked on with favor, as they are much more liable to rust than plates tinned in the old way through grease.

Cleaning the Plates.

Until quite recently the plates, as they came from the tinning machine, were cleaned of the grease by being passed through bran, dusted with sheepskin gloves and taken to the assorting room. This labor was done by girls. At one of the works, for which costs of production are given, 36 girls of the 64 employed were "branning and dusting," earning $1.81 a week. The patent cleaning machine which we illustrate (Fig. 33) does away with this female labor.

In this machine both sides of the plates are cleaned by passing them in succession through two troughs containing bran. The plates are mechanically passed through the front trough, and transferred therefrom to the second or rear trough. They are reversed or turned over at the time of transfer. Accordingly they pass through the second trough, having that face downward which was uppermost in the front trough. On arriving at the rear or delivery end of the second trough the plates are mechanically tilted on to a delivery table.

The plates are fed mechanically to the first cleaning trough. The troughs are arranged tandem, and consist of segmental cylindrical sections, across the middle of each being journaled a traverse shaft having diametrical arms, the extremities of which are provided with automatic gripping attachments that seize each sheet of tin consecutively and draw it with a downward dive through the mass of bran. The sheet being fed in is embraced by the jaws and drawn through the bran, and emerging upward is released by trip mechanism, and drops into the grip arms of the second trough, which is geared to register its movements to properly coincide. The sheet of tin is reversed in its face exposure, so that both sides are thoroughly cleansed. The operation is very rapid, and requires no handling, the sheets dropping into an ordinary pile at the end of the apparatus, much like a printing press deposits the printed sheets. The machine is so arranged that any size plates can be worked. This machine is rapidly coming into use in Wales, some 100 are now at work at some of the best mills.

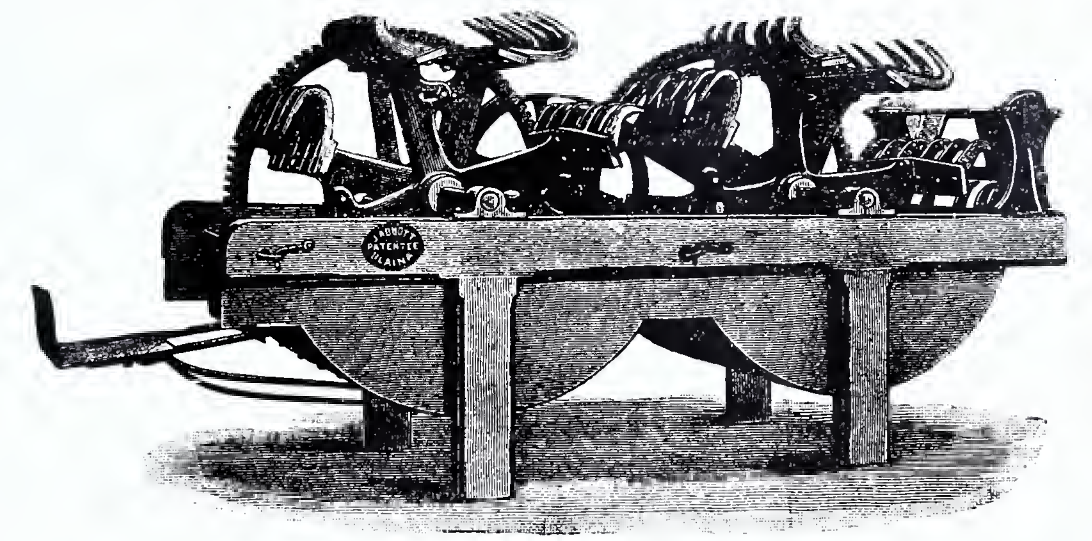


Fig. 33. The Abbott Tin Plate Cleaning Machine.

Assorting and Packing.

When cleaned the plates are assorted and thenc alled primes, wasters or waste waste. In assorting the too light or too heavy sheets are thrown out as well as the menders for retinning.

When assorted they are reckoned, weighed and boxed or packed, some best charcoal receiving between each sheet a piece of tissue paper to prevent the surface of the tin plate being scratched in transit.

When boxed they are marked with the quality, brand and destination.

A Plan of a Tin Plate Mill and Works.

We give herewith, figure 34, a ground plan of a tin plate works, showing the arrangement as suggested by an American engineer. It needs no description.

American Tin Plate Works.

The basis of the following list of tin and terne plate works in the United States, built and building, is a list furnished by the Tinned Plate Manufacturers' Association of the United States under date of January 9, 1892. We have made a number of additions to the list as well as some corrections, and have supplemented it by information specially collected. The following indicates the latest information we have regarding these works:

[3]. The American Tin and Terne Plate Company, Philadelphia, Pa.
[2]. American Tin Plate Company, E.wood, Ind.
[3]. Anderson Tin Plate Company, Anderson, Ind.
[2]. Apollo Iron and Steel Company, Apollo, Pa.
[2] Blairsville Rolling Mill and Tin Plate Company, Blairsville, Pa.
[3]. The Britton Rolling Mill Company, Cleveland, O.
[3]. Cincinnati Corrugating Company, Piqua, O.
[2]. Coates & Co., Locust Point, Baltimore, Md.
[3]. Cleveland Tin Plate Company, Cleveland, O.
[3]. Cleveland Tin Plate Company, Cleveland, O.
[3]. Columbia Tin Plate Company, Piqua, O.
[2]. Falcon Iron and Nail Company, Niles, O
[3]. Fleming & Hamilton, Pittsburgh, Pa.
[3]. Griffiths & Cadwallader, 23d ward, Pittsburgh, Pa.
[3]. Iron Clad Manufacturing Company, New York, N. Y.
[1]. Kieckhefer Bros. & Co., Milwaukee, Wis.
[3]. P. H. Laufman & Co. Apollo, Pa.
[3]. Marshall Bros. & Co., Philadelphia, Pa.
[2]. Matthai, Ingram & Co. Baltimore, Md.
[3]. McKinley Tin Plate Company, Ltd., Philadelphia, Pa.
[2]. New Philadelphia Iron and Steel Company, New Philadelphia, O.
[2]. Norton Bros., Chicago, Ill.
[1]. New Castle Tin Plate Company, New Castle, Pa.
[2]. Pioneer Tin Plate Company, Joliet, Ill.
[3] Pittsburgh Electro-Plating Company, Ltd., Pittsburgh, Pa
[2]. Pittsburgh Tin Plate Works, Strawbridge & Beaver, Kensington, Pa.
[3]. Record Manufacturing Company, Cincinnati, O.
[1]. St. Louis Stamping Company, St. Louis, Mo.
[1]. Savernake Tin Plate Company, Milford, Va.
[2]. W. T. Simpson, Cincinnati, O.
[2]. Somerton Tin Plate Works, Brooklyn, N. Y.
[2]. Strauss, J. E. Philadelphia, Pa.
[3]. Scott, J. B. & Co. Pittsburgh, Pa.
[2]. Summers Bros. & Company, Struthers, O.
[3]. N. & G. Taylor, Philadelphia, Pa.
[3]. Union Tin and Terne Plate Company, Allegheny, Pa.
[3]. United States Iron and Tin Plate Manufacturing Company, Demmler, Pa.
[3]. Wallace, Banfield & Co., Irondale, O.
[1]. Welsh American Tin Plate Company, Philadelphia, Pa
[2]. Western Tin Plate Company, Joliet, Ill.
[1]. *Organized*, 2 *building*, 3 *running in whole or part*

It may be stated that some 40 sets of tinning machinery have been sold by one house. Quite a number of works decline to give any information as to their present output or to their intentions for the future.

From the detailed reports received from the above firms and from outside information it appears that those works will have a weekly capacity when constructed of over 50,000 boxes a week. Other works contemplated, that will probably be built, which we have not included in the above will bring this total up to 75,000. This is the capacity actually operating or under construction at the present time or for which plans are being drawn. This is, at 45 weeks in the year, more than 3-5 of the imports into the United States, and nearly 1,000,000 boxes in excess of the total production of Great Britain.

A. RASNER. H. F. DINGER.

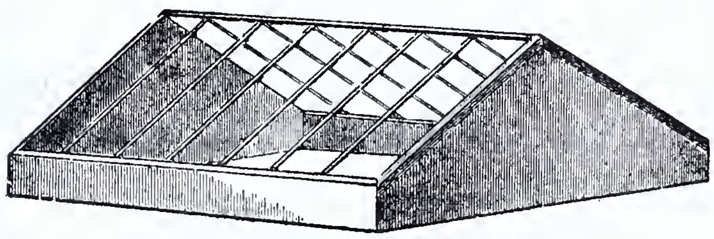
Rasner & Dinger,

MANUFACTURERS OF

Galvanized Iron Cornices,

Sheet Metal Ornaments,

Hayes' Metallic Skylights.



KINNEAR'S PATENT

SHEET STEEL CEILINGS.

Special attention to Jobbing, Spouting and Tin Roofing.

SECOND AVENUE AND FERRY STREET,

Telephone 529. PITTSBURGH, PA.

PATENTS

American and European, obtained at equitable Rates.
Special facilities for sal> of Foreign Patents
through our London House.

TRADE MARKS AND DESIGNS.

Iron Working and Tin Plate

MACHINERY

A SPECIALTY.

Patents taken out for improvements in Tinning, Pickling, Dusting machines, Blast Furnaces, Hot Air Stoves, Open Hearth, Acid and Basic Furnaces, Soaking Pits, Appliances for Rolling and Handling Iron, Machine Tools, Fuel and Illuminating Gas Apparatus, &c.

Send for *Epitome of the World's Patent Laws and Statistics.*

Competent draughtsmen employed on the premises.

The British and European Patent Agency,

252 BROADWAY, NEW YORK.

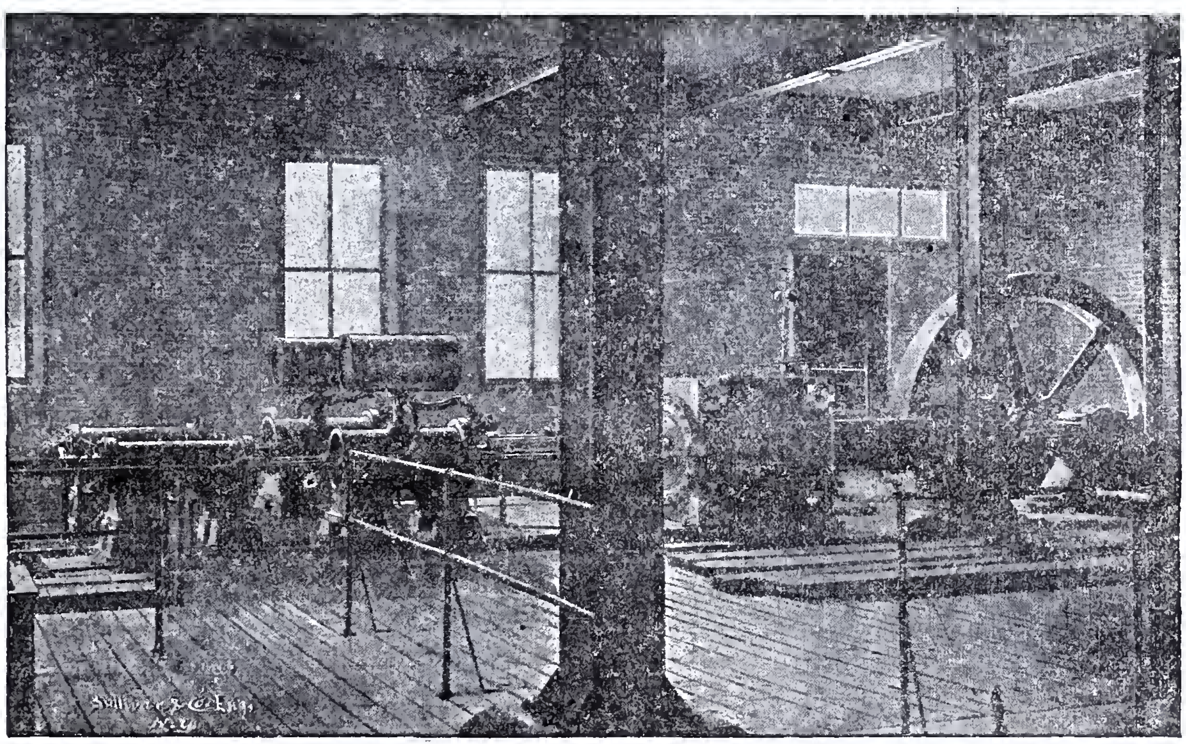
London Office: Monument Chambers, King William St., E. C.

References to this paper.

RAND DRILL COMPANY,

—MANUFACTURERS OF—

Air Compressors, Rock Drills and Mining Machinery.



This cut represents one of Rand Drill Co.'s HIGH PRESSURE AIR COMPRESSORS, built for Toledo Consolidated Street Railway Company, Toledo, Ohio, which furnishes air at a pressure of 750 lb. to their street cars, having the Mekarski system of motors. This Compressor has Compound Corliss Steam Cylinders and Compound Air Cylinders.

RAND DRILL CO., 23 Park Place, New York City, U. S. A.

AMERICAN ROOFING TIN
Made in
PHILADELPHIA
By
N. & G. TAYLOR CO.

Notwithstanding the misrepresentations of those who are opposed to the manufacture of American tin plates, we beg to say that our increased facilities now enable us to promptly fill all orders of a reasonable quantity for our American Roofing Plates.

IN ADDITION TO THE

TAYLOR "Old Style" BRAND

Extra Heavy Coated Ternes,

We are making the following Brands :

—THE—

"Taylor Roofing" AND—

"Taylor's Columbia."

Exactly the same quality as the Taylor "OLD STYLE" but carrying less Coating.

EVERY SHEET STAMPED AND RESQUARED AND QUALITY GUARANTEED.

PRICES AND FULL PARTICULARS UPON APPLICATION.

N. &. G. TAYLOR CO.,

ESTABLISHED 1810. 82d YEAR. PHILADELPHIA.

A. Milne & Co.

Bessemer, Basic and Open-hearth

Blooms, Billets, Wire Rods, &c

ALSO SPECIALTIES IN

Swedish Iron and Steel Rods

For Horse Nails, Rivets, Wire, &c.

Swedish Pig and Bars

For Steel Melting Purposes, &c.

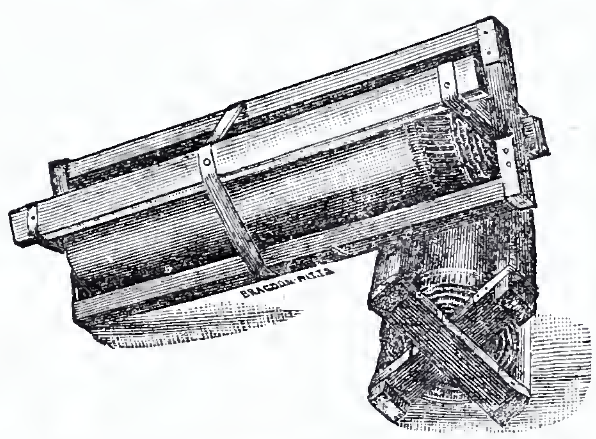
No. 1 Broadway, New York. No. 8 Oliver Street, Boston.

PATENTED

ACME STOVE PIPE.

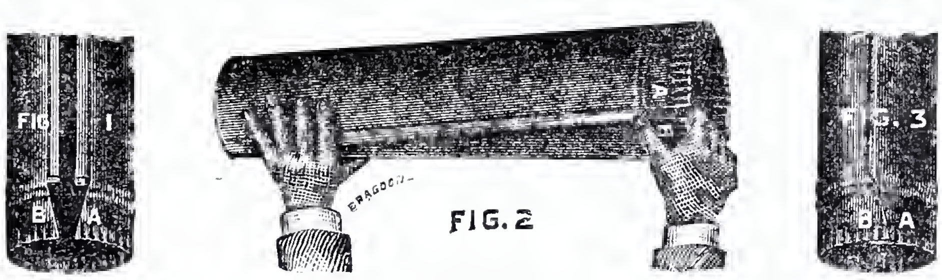
FOUR PIECED ELBOWS AND DRIPPING PANS.

The Only Practical Loose Pipe Made.



Five Hundred Tons Sold Last Year.

If you lock the seams together in figure 1, in the usual manner, the point marked A will overlap point marked B, then rest the pipe on something and place your hand as shown in figure 2; hold the right hand thumb firmly at point designated to act as a hinge, press pipe in with left hand when points A and B will open as shown in cut; then with a slight upward pressure of right hand raise point B and release the pipe from left hand, being particular to have point B overlap point A when they come together as shown in figure 3. A line of pipe thus put together cannot possibly collapse, which has always been the great objection to all other makes of what is known as knock-down pipe.

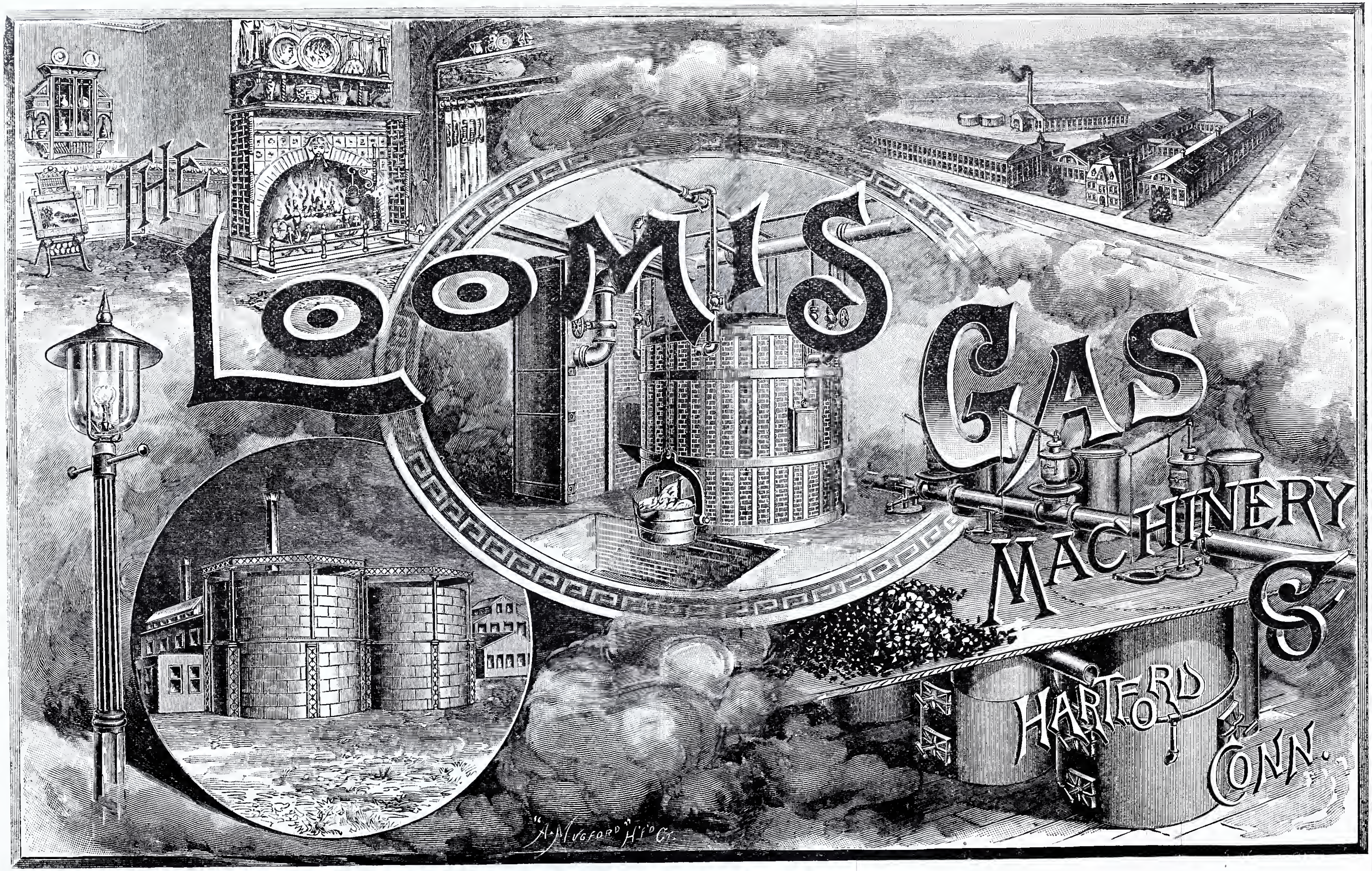


MANNER OF PUTTING ACME STOVE PIPE TOGETHER.

Can be put together instantly; no rivets or tools necessary; made from smooth Cold Rolled Iron, oiled and of good color. Twelve to 20 tons in a car. Freight rates 5th class in carloads, 3d class less than carload. Nested in crates of 25 or box of 50 joints each. For sale by all leading Hardware and Sheet Metal Jobbers.

☞Send for Sample Crate and Circular.

BUDKE MANUFACTURING CO., - - Pittsburgh, Penn'a.



LOOMIS GAS PROCESS.——Fuel Water-gas, Producer-gas, Illuminating-gas. Adapted to Industrial and Household Purposes. Special furnaces for its use for Smelting, Roasting, Forging, Melting Steel, Glass, Burning Brick, Tile, Pottery, etc. For catalogue address **BURDETT LOOMIS**, Hartford, Conn.

IMPORTERS AND DEALERS IN

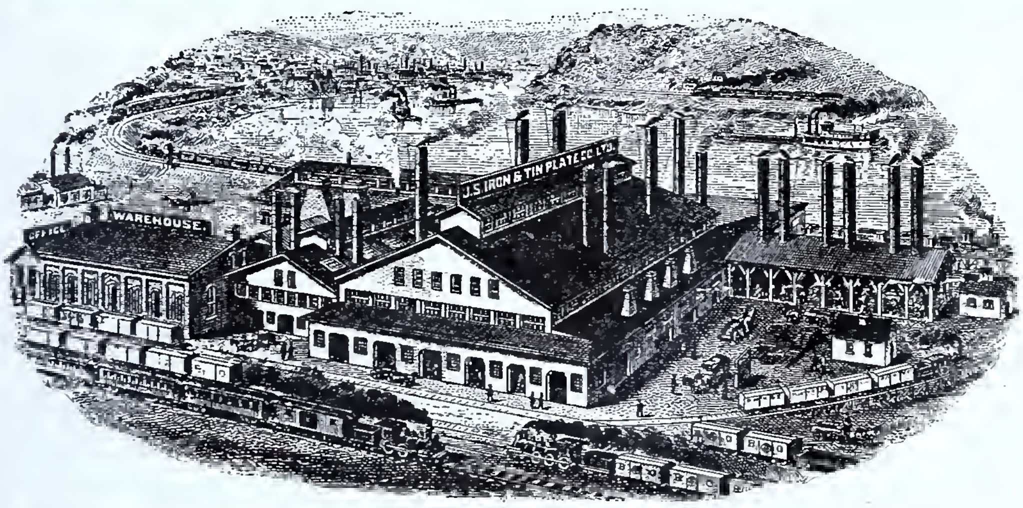
TIN PLATE, BLOCK TIN, SHEET IRON, SHEET ZINC, WIRE, ETC.

John Dunlap & Co.

28 AND 30 MARKET ST., 74, 76 AND 78 SECOND AVE., PITTSBURGH, PA.

MANUFACTURERS OF

STAMPED AND JAPANNED WARE AND TINNERS' SUPPLIES.



U.S. IRON & TIN PLATE MFG. CO.

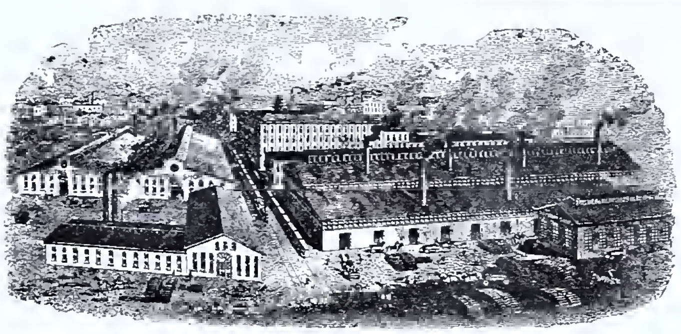
Demmler, Allegheny County, Pa.

Manufacturers of the

"Monongahela," "U. S. A. M." and "J. H." Brands of

Fine Sheet Iron & Sheet Steel,
"U. S." Tin and Terne Plate,
and "U. S." Dripping Pans.

TOTTEN & HOGG



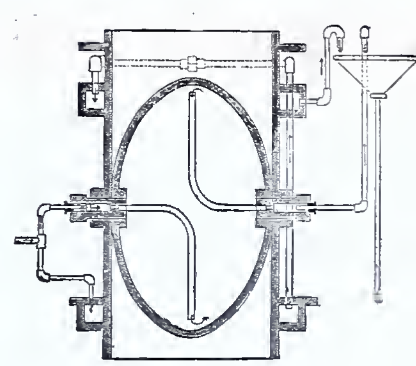
Iron and Steel Foundry Co.

——MANUFACTURERS OF——

SHEET, PLATE, BAR, BEAM, ANGLE, HOOP AND GUIDE

Rolls.

Rolling Mill Machinery and Forster's Rock Crushers; Steel Castings and Gear Wheels; Semi-steel Roughing Rolls; Higg's Pat. Water Valves for Gas Producers. These valves will stand for 6 to 9 months without having the butter-fly refitted, as the water prevents warping.



WATER VALVE.